

# Current Science



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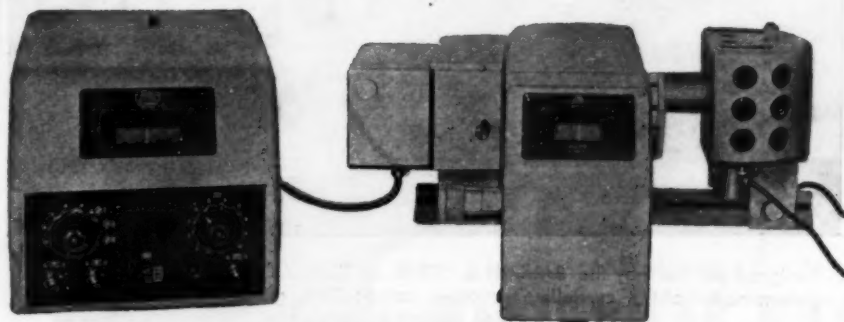
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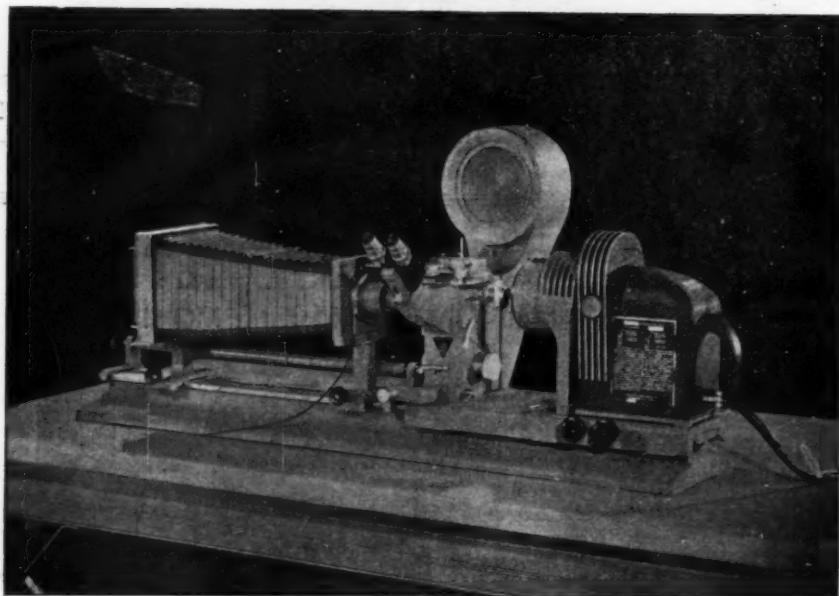
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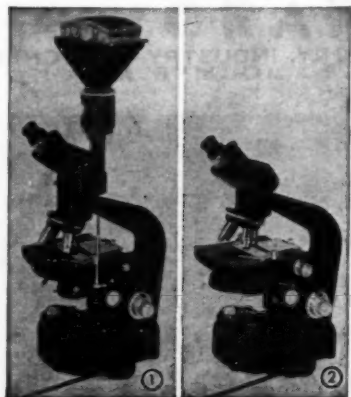
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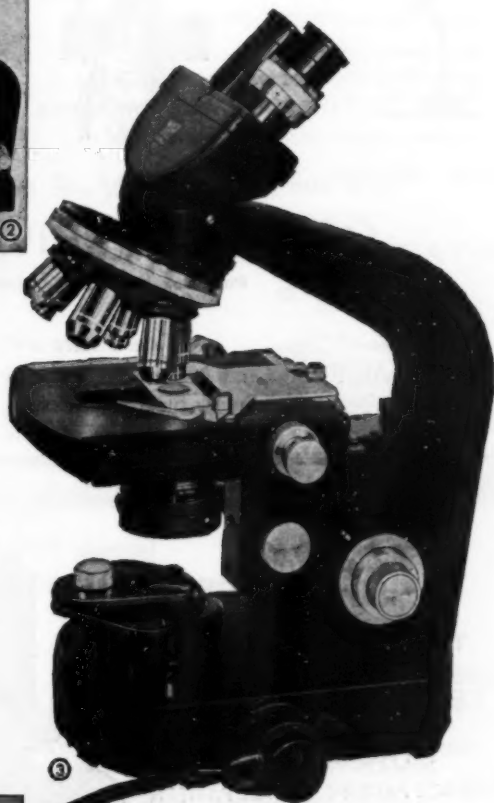


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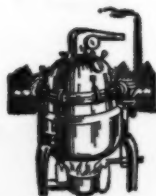
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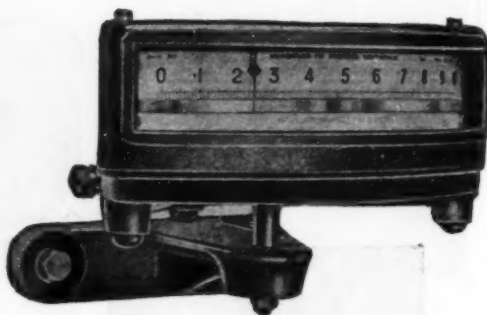
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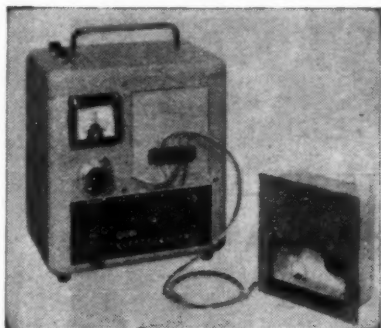
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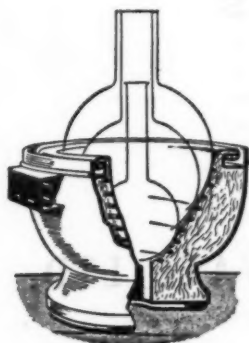
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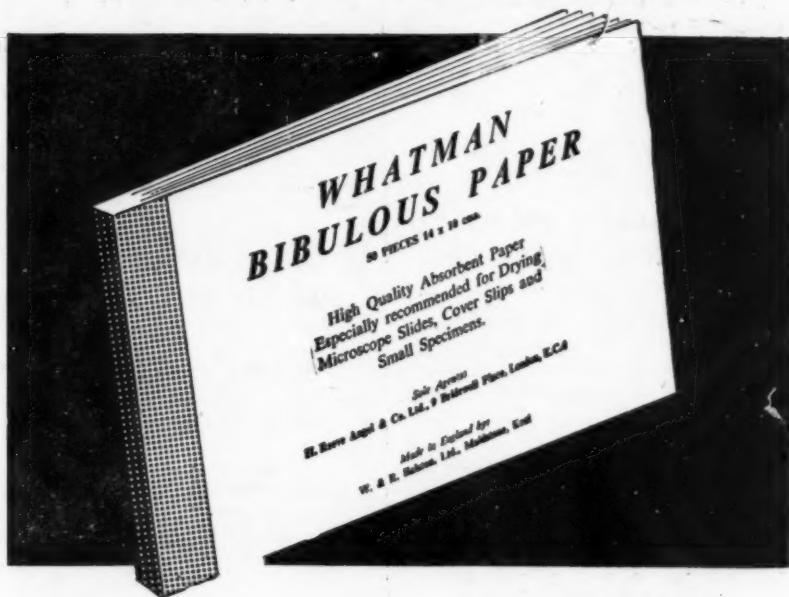
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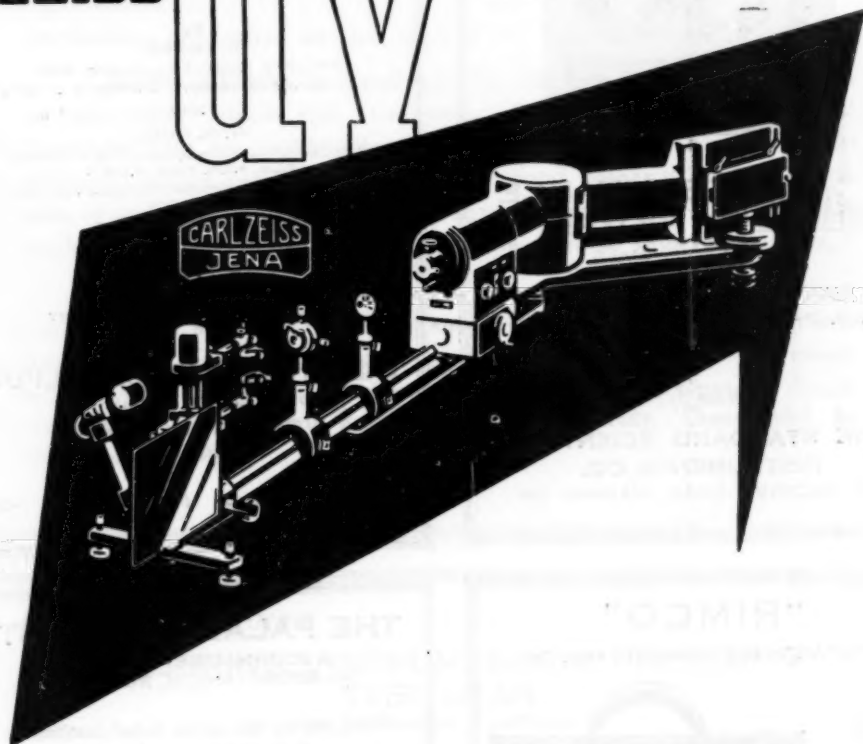
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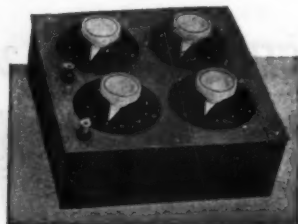
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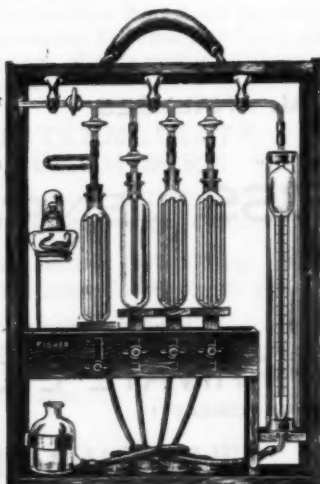


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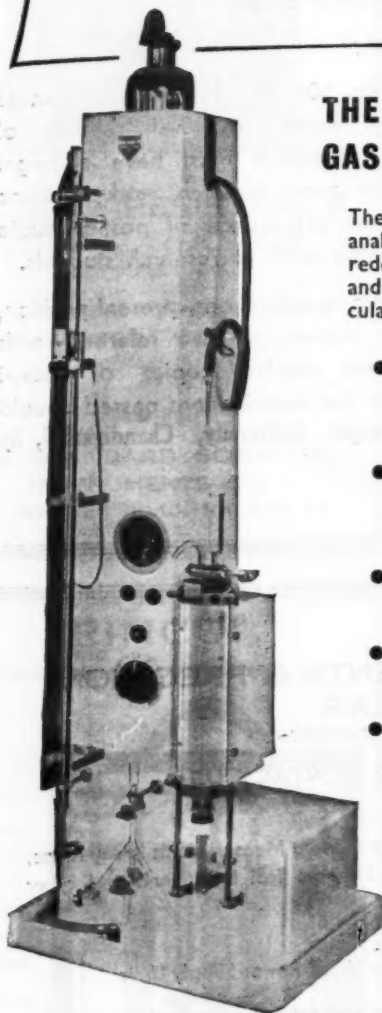
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## COSMOLOGY\*

THE universe in the large is an inevitable subject for scientific curiosity, but the most commonplace physics also leads us to study it. More generally, we conceive that the laws of physics and the actually existing physical universe must be interdependent, so that physics is bound to merge into cosmology. We may conveniently define cosmology to be the study of the astronomical universe as the system of the galaxies and any material in intergalactic space. The present time is suitable for taking stock of the subject because there seems to be a halt in its development, although much that is happening in physics and astronomy can be seen to have a bearing upon it.

The lines in the optical spectra of galaxies show a shift towards the red that increases with decreasing apparent brightness. The facts are consistent, to a good first approximation, with the interpretation that the galaxies are receding with speeds proportional to their distances. This interpretation received notable support when American observers recently found, in the few cases so far examined, that the 21 cm. line in the radio spectrum showed velocity shifts agreeing well with those in the optical spectrum. The constant of proportionality in the velocity law (Hubble's law) is written  $1/\tau$ ; it means that if the galaxies have always had their presently observed velocities they would all have coincided in space  $\tau$  years ago. The current estimate of  $\tau$ , based upon W. Baade's important revision of the distance-scale, is  $5.4 \times 10^9$  years.

The fact that so general a property as the motion of the galaxies is found to be the same for all directions, strongly indicates that the universe as a whole must be isotropic about our position. The homogeneity signifies that an observer in any other galaxy would get the same general picture of the universe as we do if the universe is in a steady state, or the same sequence of pictures if it is evolving. If valid, this is the most important thing we know about the universe, for, it means that we are in a position to know all that can be known about the astronomical universe, in the sense that we could learn nothing more about its large-scale behaviour by going anywhere else within it. If the universe is in a steady state, we could further learn no more by living at

another epoch, but this would not follow if the universe is evolving. It is in fact hard to see any justification for accepting the 'universality of physical law' unless there is also universality of physical background, i.e., homogeneity of the universe in the large. It is satisfactory to find evidence for the latter, at any rate as regards space; whether it applies also to time is one of the main points to be discussed.

The most obvious explanation of the apparent recession of the galaxies is that we are witnessing a one-way evolution of a universe whose contents are given once and for all. The mechanical behaviour of such a system is appropriately treated by Einstein's theory of general relativity. The equations obtained have a range of solutions. Those that come nearest to fitting the observations require the material to have been in a state of enormous density, infinite in the idealized model, rather less than  $\tau$  years ago. The production of this singular state is given no meaning in the theory; it must be regarded as the creation of the universe, and a unique 'age of the universe' must be dated from it.

On the other hand, the essentially simplest view is that we should suppose there to be nothing to distinguish our position in time from any other, just as we have already inferred that there is nothing to distinguish our position in space. Thus, we should suppose the universe to be in a steady state. This refers to the universe in the large or to the smoothed-out universe.

The steady-state theory of the expanding universe was propounded by H. Bondi and T. Gold and by F. Hoyle in 1948. According to the theory, existing galaxies are indeed dispersing, but, new matter is continually appearing throughout the universe and giving rise to new galaxies, thereby keeping the population distribution steady. Any large region contains galaxies of all ages, but with an average that works out at  $1/3\tau$  years. The general merits of this theory are that we avoid (a) the dubious procedure of employing unchanging laws in a changing universe; (b) the paradox of finding objects such as stars that are older than the universe; (c) the dilemma of having everything dependent upon a creation process that nevertheless is outside the scope of the theory. However, it must be understood that discrimination between the different theories depend upon effect of second or higher order near the limits of instrumental performance.

\* Based upon an article by W. H. McCrea in *Endeavour* for January 1958.



Despite the superb work done by observers, it seems that all efforts to discriminate between the theories by means of large-scale features must still be inconclusive. This seems to apply not only to optical observations but also to radio surveys. At present therefore we must consider less direct evidence.

According to evolutionary theory, galaxies must have been formed from a space-filling gas at a definite stage in the expansion of the universe. But a satisfactory process has not so far been proposed.

The steady-state theory, however, by its very nature cannot pose the problem of an original formation of galaxies. D. W. Sciama has stressed that its problem is the self-perpetuation of the existing population with all its characteristics. He has outlined a remarkable solution of the problem which is as follows.

A galaxy is, in general, in motion through intergalactic gas by virtue of its random velocity. The gas that falls towards it as it passes, forms a wake behind the galaxy, as in the well-known theory of gravitational accretion. The wake material will tend to pull itself together by its self-gravitation and so forms a 'daughter' galaxy. There is a critical condition for the daughter to break away from her parent instead of remaining gravitationally bound. If they separate, the process will start again with each galaxy. If they remain together, the process will be repeated with the pair, and by the production of further offspring a cluster of galaxies of increasing population may result. But a cluster has an inherent tendency to lose members by 'evaporation'; this and other factors hinder its growth indefinitely. The galaxies that evaporate off maintain the distribution of random motions of the field galaxies. The characteristics of this self-perpetuating system depend ultimately upon the properties of the atomic hydrogen which constitutes the bulk of the intergalactic material postulated in the theory. The theory cannot yet be regarded as established but is attractive and has no arbitrary features.

Calculations imply that 90% of all matter is intergalactic and the mean density  $\rho$  according to original theory works out to  $3 \times 10^{-5}$  hydrogen atom  $\text{cm}^{-3}$ . According to the steady-state theory the existing matter moves out of any region as a result of cosmical expansion and is replaced by 'new' matter once in about  $2 \times 10^8$  years on the average. Thus there is a creation process which must be one involving fundamental particles and producing hydrogen. Consequently at some stage it must yield protons and electrons. Calculations reveal that over a big range of temperature there will be significant fractions of both neutral and ionized hydrogen.

The concept of continual creation has not proved repugnant to current physical theory. It has indeed provoked a further line of speculation. For, 'matter' constituted of positively charged nuclei and negative electrons, and 'anti-matter' constituted of negatively charged nuclei and positive electrons, are treated in symmetric fashion by current theory. In particular, both sorts have theoretically identical inertial and gravitational properties. On general grounds we might therefore expect any creation process to produce statistically equal amounts of matter and anti-matter and the universe in the large to be composed of equal amounts. On the other hand, any particular galaxy must be composed effectively entirely of one sort only. It has even been suggested that some very energetic collisions observed to be occurring in some parts of the universe are between galaxies of opposite compositions.

The steady-state theory has survived for nine years since its announcement. Despite its peculiar vulnerability, no observation has been found to refute it that is not itself of uncertain interpretation. The obstacle regarding nuclear synthesis has disappeared and with it one of the main arguments for the evolutionary theory. The solution of the problem of galaxy formation seems to be within reach of steady-state cosmology, while older theories have not shown much progress towards solving it.

#### HAFFKINE INSTITUTE

THE Haffkine Institute, Bombay-12, will be celebrating its Diamond Jubilee from 10th to 14th January 1959.

The celebrations are expected to be inaugurated by the President of the Republic of India. The programmes will include lectures and scientific seminars on topics such as plague, cholera, rabies, influenza, poliomyelitis,

snakes, venoms and insect resistance to insecticides. These will be on international level for participation.

All scientists, scientific organisations and learned societies are invited to attend or to send delegates so as to encourage free flow of research ideas and goodwill between Research Institutions in the world.



# NUCLEAR SPECTROSCOPY: STUDY OF ALLOWED AND FORBIDDEN BETA-SPECTRA

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PRIOR to about 1950, nearly all the beta-decaying isotopes which were studied were found to give a continuous beta-spectrum conforming to the so-called 'allowed' shape, in accordance with the Fermi theory. During the last six or seven years, due mainly to the advent of atomic reactors, which could produce many artificial isotopes to high specific activity and also due to improvements in the design of beta-spectrometers, many instances of marked deviation from the 'allowed' shape have been revealed.

The shape of the beta-spectrum is one of the important criteria for deciding whether a beta-transition is allowed or forbidden under the selection rules.

The expression for energy spectrum according to Fermi theory is as follows:

$$N_{\pm}(W) dW = \left(\frac{g^2}{2\pi^2}\right) F(\mp Z, W)$$

$$p.W. (W_0 - W)^2 S_n(W) dW.$$

$W$  = energy in units of  $mc^2$ ;  $Z$  = atomic number;  $p$  = momentum in units of  $mc$ ;  $g$  = constant of interaction.

Here,  $p.W.(W_0 - W)^2$  is the statistical factor obtained on the assumption that all modes of distribution of energy between the electron and the neutrino are equally probable. The term  $F(Z, W)$  is the correction term for the effect of the Coulomb field on the emitted electron and becomes important at lower energies and higher values of atomic number. Its effect is to increase the number of 'slow' electrons and to decrease the number of 'slow' positrons. The factor  $S_n(W)$  incorporates<sup>1</sup> the specific nuclear properties relating to the initial and final states

$$[(C_s^2 + C_v^2) |M_{\tau}|^2 + (C_T^2 + C_A^2) |M_{G-T}|^2] \times \left(1 \mp \frac{b}{W}\right)$$

of the nuclei. This shape factor may or may not be energy-dependent. It can be written as to take account of the Fermi and Gamow-Teller types of interactions. In the case of 'allowed' transitions this shape factor is independent of energy,  $b=0$ , and the spectrum shape is then the statistical shape, corrected for the coulomb field effect. The spectrum shape for allowed transitions is therefore not sensitive to the precise form of interaction involved in beta-decay.

The above expression for energy spectrum can be rewritten, for 'allowed' decays, as

$$\left[\frac{N(W)}{F(Z, W) \cdot p \cdot W}\right]^2 = K(W_0 - W);$$

the quantity on the left plotted against energy  $W$  then gives a straight line, the Fermi-Kurie plot, with an intercept on the energy axis equal to  $W_0$ , the maximum beta-energy. The data on energy spectrum are presented in the form of a Kurie plot, which is a straight line for "allowed" decays, any true deviation from it being an indication that the transition in question is of the 'forbidden' type.

The selection rules governing beta-transitions are based on change in angular momentum,  $\Delta J$  and change in parity, between the initial and final states.

	$\Delta J$	Parity change
Allowed Transitions	$0, \pm 1,$	No
First forbidden Transitions	$0, \pm 1, \pm 2,$	Yes
Second forbidden Transitions	$\pm 2, \pm 3,$	No

Thus,

While allowed transitions give a straight line Kurie plot, the converse is not true as most first forbidden transitions of the type ( $\Delta J=0, \pm 1$ , yes) also give the 'allowed' spectrum shape. The spectra of Radium E( $Bi^{210}$ ) and  $Sb^{124}$  are, however, exceptions as they show a deviation from allowed shape.  $RaE$  spectrum is now explained as due to a combination of scalar and tensor interactions with  $\Delta J=1$ , yes and so also the spectrum of  $Sb^{124}$ . The explanation is

that there is an accidental cancellation of the usually dominant energy-independent terms in the spectrum shape correction factor so that the smaller energy-dependent terms begin to show up their influence.

Also, in decays where  $\beta - \gamma$  directional anisotropy exists, the spectrum shape, according to theory, must deviate from the 'allowed' shape, though the deviation may be small. For isotopes<sup>2</sup>,  $K^{42}$ ,  $As^{76}$ ,  $Rb^{86}$ ,  $I^{128}$ , such anisotropy exists, the transitions being of the type  $\Delta J=0$ ,

yes. No deviations from allowed shape have, however, been reported. For  $\text{Tm}^{170}$  and  $\text{Sb}^{124}$  ( $\Delta J=1$ , yes),  $\beta-\gamma$  anisotropy and deviations from allowed shape have been found.

It would appear that beta-transitions of the first forbidden ( $\Delta J=0, \pm 1$ , yes) type need to be more carefully studied. It has been surmised that deviations from allowed shape as predicted by theory would be more frequently revealed if experimental spectroscopy is made capable of detecting 3-5% deviations from the statistical shape.

Transitions of the type  $\Delta J=2$ , yes, are in a special class, called 'first forbidden unique'. The unique shape factor,  $(W^2-1) + (W_0-W)^2$ , gives an S-shaped uncorrected Kurie plot, with deviations from the allowed shape, both at low and high energies. Several examples of this type have been revealed in recent years, some of them being  $\text{Y}^{90}$ ,  $\text{Y}^{91}$ ,  $\text{Y}^{92}$ ,  $\text{Cs}^{137}$ ,  $\text{Ti}^{204}$ .

Second forbidden decays are not in general expected to conform to the allowed shape.

Comparative half-life 'ft' or half-life corrected for atomic number  $Z$  and maximum beta-energy,  $W_0$ , provides another criterion for deciding about the allowed or forbidden nature of a transition. Thus  $\log ft$  values seem to lie in the range 4.5 to 6 for normal allowed transitions for odd  $A$  (mass-number) nuclei and in the range 4 to 5.7 for even  $A$  nuclei.  $\log ft$  is around 3.5 for super-allowed decays, i.e., for neutron,  $\text{H}^3$  and the mirror-nuclei, and for first forbidden transitions it ranges from 6 to 8. The shape of the beta-spectrum, the  $\log ft$  value of the transition and considerations regarding the shell structure of nuclei are usually sufficient for determining the nature of the transition and the spins and parities of the initial and final nuclear states.

The deviations from allowed shape are significant at low energies, the curve bending upwards from the straight line Kurie plot. Experimental difficulties in working with beta-rays at these energies are considerable and a proper assessment of all possible sources of error is essential before reaching any definite conclusion about deviations from allowed shape. Some of these experimental considerations are as follows:

(1) Absorption in the window of the counter.

(2) Scattering of electrons in source material and from the source-backing.

(3) Spectrometer resolution correction, which can be tested by studying the shape of internal conversion lines in different regions of energy.

(4) Effect of the design of baffle-edges as penetration through the edges at high energies can affect the shape of the spectrum. A sharp-edged or sharp-cornered baffle in front of the detector can enhance the high energy portion ( $\sim 1.5$  Mev.) by several per cent.

(5) Stability of the detector.

(6) Remanence in the iron of spectrometer magnet, which may change its current-field characteristic.

Corrections for effects (1) and (2) above can best be assessed by a number of auxiliary experiments,<sup>3</sup> using different values of thickness for counter window and source-backing. A good experimental approach for eliminating several rather ill-defined errors is to use a method of comparison where the spectrum from a given source is compared, under identical conditions, with that of a source known definitely to give a straight-line Kurie plot. Greater confidence can then be placed even in small, observed deviations from the allowed shape.

In conclusion it may be said that the study of forbidden beta-transitions is essential as the expectations for such transitions are more sensitive to differences in the formulation of the theory than those for allowed decay. The recent discovery of non-conservation of parity in weak interactions has reopened the question of the type of interaction involved in beta-decay and has stimulated experimental investigation and re-examination of many problems<sup>4</sup> which were considered to have been settled.

1. *Beta and Gamma-Ray Spectroscopy*, Edited by K. Siegbahn, Articles by M. E. Bose, C. S. Wu and Konopinsky.

2. Porter, F. T., *et al.*, *Phys. Rev.*, 1957, **107**, 135 and *Ibid.*, 1956, **103**, 921.

3. Subba Rao, B. N., *et al.*, to be published.

4. Berestetsky *et al.*, *Nuc. Phys.*, 1958, **5**, 464.

## RECENT ADVANCES IN AIRPHOTO GEOLOGY

PETER E. WOLFE\*

**A**IRPHOTO Geology is a science dealing with the examination, interpretation and preparation of geologic maps from aerial photographs. The form, pattern, and broader relation of rock bodies can be studied more quickly and more effectively on photos than on the ground and in many instances features or relations which are absent to the observer in the field are readily apparent on photos. The aerial camera is an extremely efficient recorder of many of the important field data and provides a means literally of bringing the field into the laboratory. Airphotos likewise provide the most economic means of surveying and result in more detailed geologic maps at a fraction of the cost of older field surveying methods.

The geologic interpretation of aerial photographs requires a well rounded knowledge of general geology. Familiarity with geologic maps and with the solid geometry of rock bodies is important and field experience is invaluable as a background. Any type of airphoto may be used for geologic interpretation, the relative merits of each depending on the particular problem at hand. For reconnaissance work, oblique photographs and mosaics are advantageous for studying large-scale features and trends. Vertical photographs with stereoscope coverage are best for detailed work especially since they may be viewed in three dimensions and the relief or terrain features studied in conjunction with the rock outcrop and structural patterns.

Aerial photographs may be used for geologic mapping either in the office or in the field. Office mapping is obviously limited in scope and its success is dependent upon adequate exposures. Under favourable conditions, photos alone may supply a large part of the information needed in mapping, but they can never supply quite all the necessary data. Office mapping consists essentially in the systematic applications of the criteria for lithologic, structural and topographic interpretation of aerial photographs. In economic geology it is sometimes necessary to obtain, in a minimum amount of time, all possible information about areas which are not readily accessible from the ground, such as in rough mountainous re-

gions, jungle areas, etc. In such cases provisional maps may be prepared solely on the basis of aerial photos. The boundaries of rock types may or may not be shown. In some instances it may be sufficient to show only the general structural trends using appropriate symbols for faults, axial traces of anticlines and synclines, dip and strike of strata and outcrops of igneous rock bodies. The reliability of this type of mapping varies inversely with the complexity of structure. Although a thoroughly accurate map may be prepared under ideal conditions, there are many sources of error and the results are provisional until confirmed in the field.

In geologic field mapping, aerial photographs may be used both as guide maps in finding desired localities and outcrops and as base maps for recording geologic data. As guide maps they are unexcelled, providing a complete and detailed picture of roads, trails, clearings, streams, ridges and landmarks of all types, as well as showing the places where outcrops can be found. Generally it is possible to locate oneself very quickly by visual comparison with the ground features and the photographic detail. Using airphotos, it is possible at the beginning of each day's work to plan the traverses in considerable detail. Promising points for investigation are noted and the best routes between points are decided upon. In this way, small but important exposures which otherwise might be found only by chance, may be located and conversely, unpromising areas may be excluded from the traverse route. On the completion of a given unit of the field work, the photos provide a basis for interpolating boundaries between points visited, as well as integrating scattered observations on general geology and finalizing a detailed geologic map.

The basic phases of geologic interpretation from aerial photos include the identification and delimitation of rock structure and interpretation of landforms and drainage patterns. Structural interpretation is mainly a matter of determining the solid geometry of the rock bodies. Accurate differentiation and correlation of lithologic units constitutes the first step and is followed by a study of the distribution and attitude of the geologic formations and their relations to one another. Where the rocks involved in the structure are fully exposed, as in arid regions of some relief, their structural

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relations may be observed and mapped directly. Where the structures are not directly exposed, but the outcrop belts of certain distinctive rocks are traceable through the soil and vegetation, the type of structure may be deduced from the outcrop pattern and its relation to topography and vegetative cover. Stream drainage patterns likewise are valuable as indicators of general structural trends. Dendritic or tree-like patterns indicate areas of horizontal sedimentary or uniform igneous rocks. Trellis patterns indicate folded sedimentary rocks with anticlinal, synclinal and monoclinal structures; radial patterns show domal structures, etc. The approximate dip and strike of rocks can likewise be easily measured through stereoscopic or three-dimensional studies of vertical photographs. The geologic identification and delimitation of rock types and structure and the interpretation of drainage patterns and terrain are closely interrelated and together lead to more specialized phases such as its application to mining, petroleum and engineering geology and research problems in dynamic geology.

In the mining industry aerial photographs are widely used for the discovery and development of new mineral deposits and extension of old ore bodies. During the past 25 years large areas of the United States, Canada, Africa, South America, Australia and other countries have been photographed and air-borne magnetometer surveys made in order to discover new mineral deposits. These surveys were made partly for the purpose of providing base maps and partly to permit a direct search for such evidences of mineralization as might be shown on the photos. Insofar as primary ore deposits are concerned the latter is mainly a matter of lithologic and structural interpretation involving the recognition of actual outcrops of gossan, mineralized aureoles, veins or lodes, or of rock bodies or other geologic relations which might be expected to have mineral deposits associated with them. Careful study of the aerial appearance of known ore deposits provides a guide in the search for other deposits of a similar character in the general region. Thus, through a detailed examination of aerial photographs, areas which appear promising for ground prospecting are selected, and areas which appear to be unfavourable are eliminated.

In the detailed study of established mining districts, aerial photos are valuable for routine surface mapping of the geology. This involves the plotting of all outcropping veins or other

type of deposits, together with associated faults, folds, fractures and lithologic units which may have influenced the localization of the ore. Minor fractures, faults, and other features difficult to recognise on the ground are frequently shown very clearly on photos and when their relation to mineralization has been established may provide a clue to new ore bodies. Likewise the use of the air-borne magnetometer in conjunction with aerial surveys has been valuable in discovering new ore deposits. In the United States one of the large steel companies, which imports iron from mines more than a thousand miles away, carried out a magnetometer survey on land-holdings adjacent to their steel plant. Much to their surprise a large new magnetite iron ore body was discovered in their own backyard. The extension of large nickel deposits in Canada also were made using similar air-borne surveys.

The costs of aerial photo surveys in mining operations varies according to the size and shape of the area, scale of the maps, amount of existing ground control and detail required. For areas of 1,000 acres or larger, the air-borne method always costs less than ground surveys. For example, the mapping of a 7,000-acre coal mining area in the Central United State cost \$1.84 per acre whereas ground surveys for a nearby area of similar size with identical terrain cost \$2.92 per acre. Furthermore, much more detail was furnished in the aerial maps which was invaluable in planning the long-term mining operations.

The monetary savings in air-borne magnetometer surveys are even more striking. For example, in the Adirondack Mountain area of Upper New York State, a large magnetite iron ore deposit was located through air-borne surveys. During this aerial survey, a 4-man crew operating an aircraft made 11,300 miles of magnetic traverse lines spaced  $\frac{1}{4}$  mile apart. It was estimated that, under the rugged mountainous terrain present, a 4-man crew making a dip needle ground survey would have required 27 years of six-month field seasons or 80 times the period and have cost 17 times as much as the aerial surveys. The final results also would have been much less accurate and the development of the mining operations would have been delayed by many years.

In the petroleum industry the use of aerial photos both for geological and engineering purposes has become standard practice. Aerial photographs provide a rapid and economical means of preparing base maps of various types and scales, particularly in unmapped

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inadequately mapped territory, and thus aid in many phases of developmental work. Surface indications of petroleum such as oil seeps, anticlinal structures, and other types of potential structural traps are often shown with striking clarity on aerial photos. In undeveloped jungle country difficult of access, aerial photographs provide the only guide and efficient way

ocean platforms and continental shelves, aerial photographs provide the only means of accurately locating the subsurface structures. Extensive use of aerial photos in conjunction with 'shoram' and air-borne magnetometer surveys have been made in the West Indies and Gulf of Mexico in developing new oil-fields in submerged continental shelf areas.

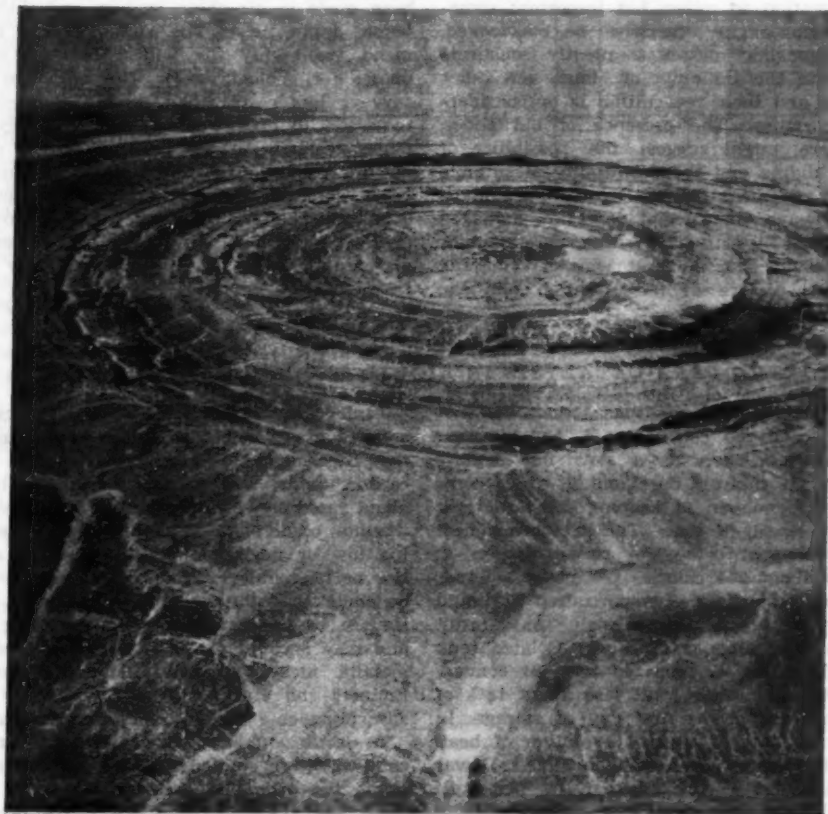


FIG. 1. Oblique Aerial Photograph showing Planed-off Structural Dome in Mauritania, French West Africa

of locating either definite structures or places where there is some hope that such structures may be outlined by ground methods. They aid furthermore in appraising the regional geologic setting of individual areas and in selecting the best routes to places of seeing promise for ground study. In this way random traverses are avoided, much fatiguing and unprofitable travel is eliminated, the range of geologic exploration is greatly extended, and essential field work is held to a minimum. Again in the exploration for oil in offshore areas along the

In the field of Engineering Geology, air-photos find widespread application. They provide a base map for the preliminary surveys or mapping required for many types of engineering projects. Skilled geologic and physiographic interpretation of the photos may aid both in contributing to the economy and efficiency of purely routine geologic work, and in directing attention to such features as active faults, sinkholes, landslides, glacial deposits and ancient stream channels which might have an important bearing on the cost or success of

the project in question. In light of the information thus gained, boreholes, test pits, or trenches, or other types of subsurface exploration may be planned most effectively. In detailed geologic mapping of sites for tunnels, aqueducts, dams, reservoirs and other types of engineering projects, faults, fractures, and other sources of weakness in the rock are of particular concern and aerial photos might direct attention to minor but important structures, which might otherwise be overlooked. Ancient landslide masses frequently constitute obstacles to the building of dams and other structures and their recognition is of considerable importance. The presence of old slides, furthermore, might suggest the possibility of repeated sliding and the desirability of suitable precautionary measures. In cases where highways, railways, canals, and dams are damaged or obstructed by active landslides, aerial photographs provide the quickest way of obtaining a complete picture of the situation and the

remedial measures to be taken. Aerial photos are very helpful in studying the effects of the silting of reservoirs and the control of erosion and deposition along rivers and harbours. They also are invaluable for the development of new surface and subsurface water-supplies, dam, reservoir and irrigation projects.

In conclusion the descriptions given above indicate in a brief way the advances that have been made in air-photo geology and their economic applications. The author cannot recommend too highly the widespread use of air-photos for geologic work. Not only are aerial surveys less costly than ground surveys, but they add to greater detail and accuracy. Air-photo geologic surveys likewise can be carried out in a fraction of the time of ground surveys; sometimes advancing the development of a mineral prospect by many years. In advanced civilizations, time is an important element and air-photo geology is an important new scientific tool.

#### ORTHO-PARA-CATALYSIS IN LIQUID-HYDROGEN PRODUCTION

FRESHLY liquefied hydrogen that has not been catalyzed consists of a 3-to-1 *ortho*-*para*-mixture. There is a slow but definite change in the mixture on standing, which complicates the problem of keeping the liquid for any great length of time. The exothermic heat of conversion of *ortho*- to *para*-hydrogen at 20° K. is about 254 calories per mole, whereas the endothermic heat of vaporization of liquid hydrogen is 216 calories per mole. As a result of this slow change, a thermally isolated tank of liquid hydrogen, prepared without conversion to the *para* form, will lose about 18% of its volume during the first day of storage. In the absence of this internal evolution of heat, the heat transfer to a well-insulated Dewar may result in a loss of less than 1% per day.

The obvious solution of the above difficulty is the conversion to the *para* form either in the gas phase before liquefaction or in the liquid phase immediately after liquefaction, but in any case before delivery to the storage Dewar.

Bonhoeffer and Harteck were the first to make use of heterogeneous catalysis to establish *ortho*-*para*-equilibrium. They used charcoal at liquid-air temperatures and were able to establish equilibrium quickly when normal hydrogen was passed over the catalyst. However, when *para*-hydrogen was passed over charcoal at room temperature, no conversion took place.

Taylor and collaborators studied the catalytic activity of the metallic oxides and found that the *para*-magnetic substances chromic oxide, cerium oxide, and neodymium oxide brought about rapid conversion, whereas zinc oxide, lanthanum oxide, and vanadium pentoxide, having low or negligible *para*-magnetism, showed low or negligible conversion efficiencies. They conclude that the magnetic character of the surface of the catalyst is a controlling factor and may account for their earlier success with metallic nickel, as well as for the results of Emmett and Harkness with Van der Waal's adsorption on iron synthetic ammonia catalysts.

A series of selected or specially prepared catalysts were studied for their ability to accelerate the *ortho*- to *para*-conversion of hydrogen. The results of this study are presented, and the performance of various catalysts are compared with that of chromic oxide on alumina pellets. An outstanding catalyst, unsupported hydrous ferric oxide granules, was selected for further study and used in the liquefiers of the National Bureau of Standards Cryogenic Engineering Laboratory. One and half litres of this catalyst has now been used to convert more than 100,000 litres of liquid hydrogen to 90-95% *para* at an average rate of about 235 litres of liquid per hour. There is to date no evidence of decrease in efficiency with continued use.



## STACKING FAULTS IN CLOSE-PACKED METALLIC LATTICES

## Part II. The Measurement of Faulting Parameters

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X-RAY DIFFRACTION FROM FAULTED  
CLOSE-PACKED LATTICES

IN Part I of this review<sup>1</sup> some general considerations were set forth and in this the quantitative estimation of stacking faults by X-ray methods will be dealt with. Detailed treatments for the X-ray diffraction effects of f.c.c. and h.c.p. lattices containing growth of deformation faults have been given by several authors.<sup>2-6</sup> A simple composite picture of the diffraction effects for the four different faulted lattices has not, however, been given so far.

The X-ray reflections from a structure which builds up in accordance with a space group can be represented in a reciprocal lattice where the lattice points, each representing a particular reflection, are similar, i.e., identical except in intensity. In the case of f.c.c. and h.c.p. structures, it is possible to represent the corresponding reciprocal lattices in a common diagram with conventional hexagonal indices

(Fig. 1). The corresponding hexagonal indices

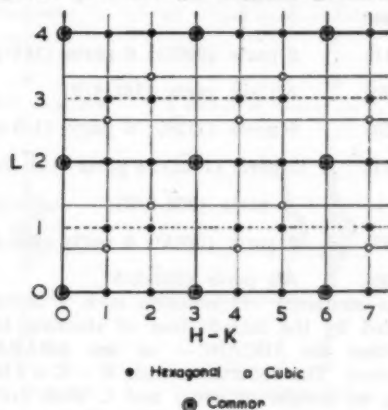


FIG. 1. Reciprocal lattice for close packed structures (Reflections from both h.c.p. and f.c.c. lattices are indicated.)

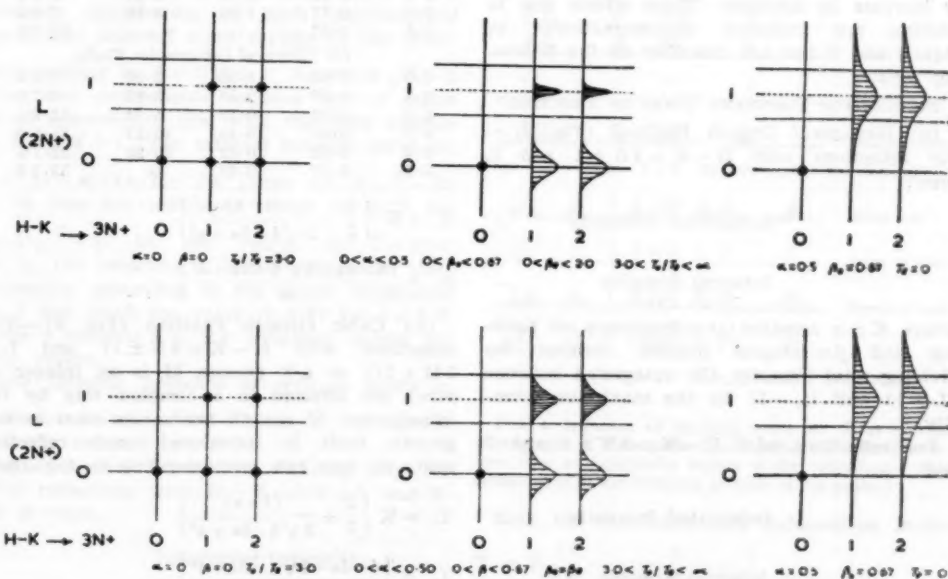


FIG. 2. Reciprocal lattice representation of X-ray diffraction effects of stacking faults in h.c.p. structures. (The line profiles indicate distribution of intensity along the L-axis. Effects of growth and deformation faults are shown above and below respectively.)

HKH + KL) for f.c.c. reflections (hkl) can be computed from the simple relations:

$$H = \frac{(-h+k)}{2}; K = \frac{(-k+l)}{2}; L = \frac{(h+k+l)2}{3}$$

The first few f.c.c. reflections, some of which actually represent a family of reflecting planes, can then be assigned the following hexagonal indices:

- (111) .. 2 parts (0002); 6 parts (10 $\bar{1}$ -2/3)  
 (200) .. All six parts (10 $\bar{1}$ -4/3)  
 (220) .. 6 parts (11 $\bar{2}$ ); 6 parts (10 $\bar{1}$ -8/3)  
 (311) .. 12 parts (11 $\bar{2}$ ); 6 parts (10 $\bar{1}$ -10/3);  
           6 parts (20 $\bar{2}$ -2/3);  
 (222) ... 2 parts (0004); 6 parts (20 $\bar{2}$ -4/3)  
 (400) .. All parts (20 $\bar{2}$ -8/3).

The similarity of points in such a lattice is affected by the introduction of stacking faults in either the ABCABC— or the ABABAB— sequence. The reflections with  $H-K=3N$  ( $N$  being an integer or zero) and  $L$  even are not affected in any way by faulting; they are sharp and have the same intensity as in the perfect lattice. But all other reflections broaden out along the  $L$ -axis and in some cases also decrease or increase in intensity. These effects due to faulting are indicated diagrammatically in Figs. 2 and 3 and are described in the following section.

#### RESULTS FOR DIFFERENT TYPES OF FAULTING

(a) Hexagonal Growth Faulting (Fig. 2).—For reflections with  $H-K=3N \pm 1$  and  $L$  even:

Integrated Intensity ..

Integral Breadth ..

where  $K=a$  constant;  $a$ =frequency of faulting and  $\beta$ =integral breadth obtained by dividing total intensity ( $T$ ) integrated between  $(L+1)$  and  $(L-1)$  by the maximum intensity.

For reflections with  $H-K=3N \pm 1$  and  $L$  odd:

Integrated Intensity ..

Integral Breadth ..

Accordingly, all reflections with  $H-K=3N \pm 1$  and  $L$  odd or even, broaden out in the  $L$  direction when growth faults are gradually

introduced into the lattice. The reflections with  $L$  even broaden out exactly three times as much as those with  $L$  odd. They also gradually lose their intensity in favour of the latter. At  $a=0.5$ , the reflections with  $L$  even disappear and those with  $L$  odd increase in intensity by a third of their original values and attain their maximum breadth of 0.67 (in terms of  $L$ ). When  $a$  exceeds 0.5, the structure enters the f.c.c. region and can be considered a heavily growth-faulted f.c.c. structure.

Table I gives the integral breadths ( $\beta_o$  and  $\beta_e$ ) for reflections with  $H-K=3N \pm 1$  and  $L$  odd or even, the ratios ( $T_o/T_e$ ) between the integrated intensities of reflections with  $L$  odd and even and the increase in intensity ( $\Delta T$ ) of the lines with  $L$  odd, for various values of the faulting parameter ( $a$ ).

TABLE I  
X-ray diffraction effects of stacking faults in  
h.c.p. structures

$a$	$\beta_o$	$\beta_e$	$T_o/T_e$	$\Delta T_o$
(a) Effects of Growth Faults				
0.0	0.00	0.00	3.00	0.0%
0.1	0.06	0.17	3.02	0.2%
0.2	0.13	0.38	3.10	0.8%
0.3	0.22	0.67	3.33	2.6%
0.4	0.37	1.10	4.16	7.5%
0.5	0.67	..	$\infty$	33.3%
(b) Effects of Deformation Faults				
0.0	0.00	0.00	3.00	0.0%
0.1	0.16	0.16	3.82	5.7%
0.2	0.32	0.32	5.52	12.9%
0.3	0.49	0.49	10.23	21.5%
0.4	0.62	0.62	35.25	22.7%
0.5	0.67	0.67	$\infty$	33.3%

$$T_o = K \left\{ \frac{1}{2} + \frac{(1-a)}{2\sqrt{4-8a+a^2}} \right\}$$

$$\beta_o = \left\{ \frac{4-4a-2\sqrt{4-8a+a^2}}{a} \right\}$$

(b) Cubic Growth Faulting (Fig. 3).—The reflections with  $H-K=3N \pm 1$  and  $L=2M+2/3$  or  $4/3$  (where  $M$  is an integer or zero) are affected in a complex way by the introduction of growth faults. As soon as one growth fault is introduced, each reflection splits up into two, corresponding to the alter-

$$T_o = K \left\{ \frac{1}{2} + \frac{(1-a)}{2\sqrt{4-8a+a^2}} \right\}$$

$$\beta_o = \left\{ \frac{4-4a-2\sqrt{4-8a+a^2}}{3a} \right\}$$

native twinned arrangements of the f.c.c. lattice. As  $a$  increases from zero, the sharp twin reflections broaden out asymmetrically with

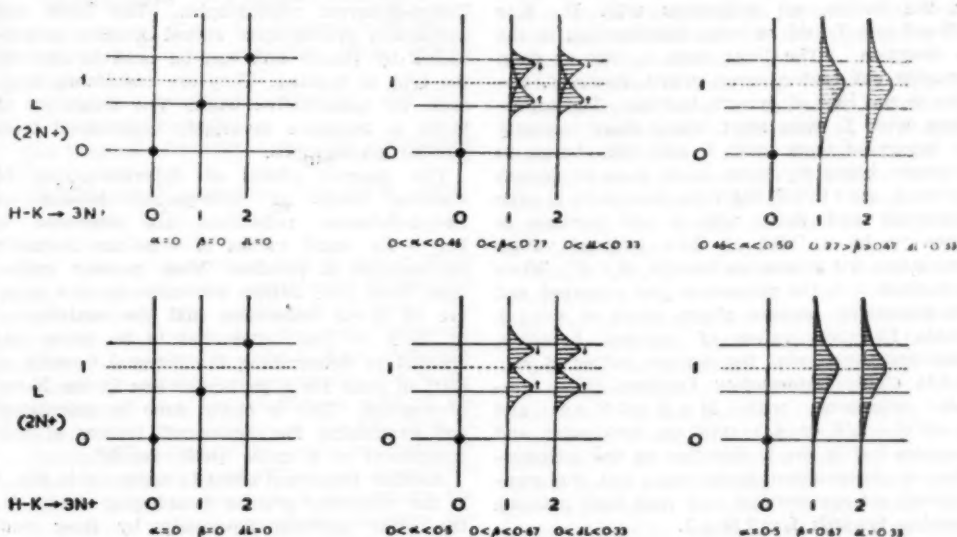


FIG. 3. Reciprocal lattice representation of X-ray diffraction effects of stacking faults in f.c.c. structures (The line profiles indicate distribution of intensity along the L-axis. Effects of growth and deformation faults are shown above and below respectively.)

their peaks moving towards each other. The intensity distribution of each asymmetrical component falls off more rapidly in the direction leading to  $L = 2M + 1$ . At  $\alpha = 2\sqrt{3} - 3$ , these two components coalesce into a single broad symmetrical line with the peak exactly at  $L = 2M + 1$ . The integral breadth given by

$\beta = 2(1 - \alpha)/3\alpha$  for the range  $\alpha = (2\sqrt{3} - 3)$  to  $1/2$  has the maximum value of 0.77 for  $\alpha = 2\sqrt{3} - 3$ . In the region  $(2\sqrt{3} - 3) < \alpha < 1/2$ , the breadths of these reflections start decreasing according to the above expression for  $\beta$  and reach the value of 0.67 for  $\alpha = 0.5$ . When  $\alpha$  exceeds 0.5, the structure enters the h.c.p. region.

The integral breadths as well as shifts in peaks for the range  $0 < \alpha < (2\sqrt{3} - 3)$  cannot be easily evaluated.

(c) Hexagonal Deformation Faulting (Fig. 2). —For reflections with  $H - K = 3N \pm 1$  and  $L$  odd or even.

Integrated Intensity ..

Integral Breadth ..

$$T_o = K \left\{ \frac{1}{2} - \frac{1}{4\sqrt{1-3\alpha+3\alpha^2}} \right\}$$

$$T_e = K \left\{ \frac{1}{2} + \frac{1}{4\sqrt{1-3\alpha+3\alpha^2}} \right\}$$

$$\beta_o = \beta_e = 2 \cdot \frac{1 - \sqrt{1-3\alpha+3\alpha^2}}{1 + \sqrt{1-3\alpha+3\alpha^2}}$$

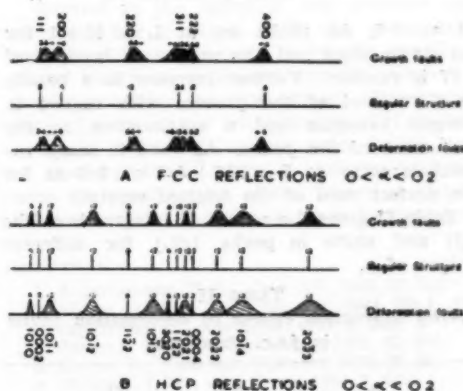


FIG. 4. Influence of stacking faults on X-ray powder photographs of close-packed structures. (The small numbers refer to multiplicity factors of the reflections. The arrows refer to the direction of shift of the peaks.)

With the introduction of deformation faults

in the lattice, all reflections with  $H-K=3N \pm 1$  and  $L$  odd or even, broaden out in the  $L$  direction. The lines with  $L$  odd or even broaden out to the same extent, however, unlike in the case of growth faulting. The reflections with  $L$  even start losing their intensity in favour of those with  $L$  odd, the change in intensity being far more rapid than in growth faulting. At  $\alpha=0.5$ , the reflections with  $L$  even disappear and those with  $L$  odd increase in intensity by a third of their original values and attain the maximum breadth of 0.67. When  $\alpha$  exceeds 0.5, the process is just reversed and all reflections become sharp again at  $\alpha=1.0$ . Table I b gives values of integral breadths, intensity ratios, etc., for various values of  $\alpha$ .

(d) Cubic Deformation Faulting (Fig. 3).—All reflections with  $H-K=3N \pm 1$  and  $L=2M+2/3$  or  $4/3$  split up into pairs and broaden out in the  $L$  direction on the introduction of deformation faults also, but the components are symmetrical now with their maxima moving towards  $L=2M+1$ .

Integral Breadth

$$\beta = 2 \cdot \frac{1 - \sqrt{1 - 3\alpha + 3\alpha^2}}{1 + \sqrt{1 - 3\alpha + 3\alpha^2}}$$

Shift in Maximum

$$dL = \pm \left\{ \frac{1}{3} - \frac{1}{\pi} \arctan \sqrt{3} \cdot (1 - 2\alpha) \right\}.$$

At  $\alpha=0.5$ , the peaks are at  $L=2M+1$  for the single lines and the maximum breadth of 0.67 is reached. Further increase in  $\alpha$  results in a reversal of the process with regard to integral breadths and a continuation in the movement of the peaks. At  $\alpha=1.0$ , sharp reflections occur at  $L=2M+4/3$  or  $2/3$  as for the perfect twin of the original crystal.

Table II gives the values of integral breadths ( $\beta$ ) and shifts in peaks ( $dL$ ) for different values of  $\alpha$ .

TABLE II

X-ray diffraction effects of deformation faults in f.c.c. structures

$\alpha$	$\beta$	$dL$
0.0	0.00	0.00
0.1	0.16	0.03
0.2	0.32	0.08
0.3	0.49	0.14
0.4	0.62	0.23
0.5	0.67	0.33

#### APPLICATION OF RESULTS TO POWDER PHOTOGRAPHS

The preceding results can be used to detect and evaluate stacking faults in close-packed structures from their Laue, Oscillation or

Debye-Scherrer photographs. The Laue and Oscillation photographs reveal streaks as predicted by theory and can be used to identify the type of faulting. They are unsuitable, however, for quantitative work. The frequency of faults is therefore invariably determined from powder photographs.

The general effects of different types of stacking faults in close-packed lattices on Debye-Scherrer reflections are indicated in Fig. 4 for small values of  $\alpha$  as are normally encountered in practice. Most powder reflections from f.c.c. lattices are made up of a number of X-ray reflections and the contribution of each of the latter has to be taken into account in determining the integral breadth or shift in peak for a particular line in the X-ray photograph. This is easily done by calculating and examining the hexagonal indices of each component of a cubic ( $hkl$ ) family.

Another important effect brought out in Fig. 4 is the relatively greater broadening shown for the same faulting frequency by lines with

higher  $L$  values in a family of reflections having same  $H$  and  $K$  values. This is because the spread of deviation angle for a small variation in  $L$  is greater in powder photographs for higher numerical values of  $L$  when  $H$  and  $K$  are the same. This effect can be taken into account by differentiating with respect to  $L$ :

$$\sin^2 \theta = \lambda^2 \cdot \left\{ \frac{H^2 + HK + K^2}{3a^2} + \frac{L^2}{4c^2} \right\}$$

the equation connecting the Bragg angle ( $\theta$ ), wavelength of the X-radiation ( $\lambda$ ), hexagonal lattice parameters ( $a$  and  $c$ ) and the indices of reflection ( $HKH + KL$ ). The differentiation leads to:

$$d\theta = \frac{\lambda^2 \cdot L \cdot dL}{2c^2 \cdot \sin^2 \theta}$$

Since  $2d\theta$  represents the measurable angular breadth ( $\beta_\theta$ ) due to diffraction for a powder line and  $dL$  represents the integral breadth in reciprocal space ( $\beta$ ) which is needed for the evaluation of  $\alpha$ , the above equation can be written as:

$$\beta = \frac{c^2 \cdot \beta_\theta \cdot \sin 2\theta}{\lambda^2 \cdot L}$$

$\alpha$  is normally evaluated from graphs connecting  $\alpha$  and  $\beta$ .

## MEASUREMENT OF FAULTING PARAMETER

The values of  $\alpha$  can be obtained from any of the following data available from powder photographs:

- (a) Shifts in intensity maxima (for f.c.c. structures only).
- (b) Integral breadths due to diffraction alone.
- (c) Integrated intensities (for h.c.p. structures only).
- (d) Line shapes.

The observed line-broadening is due in many cases both to stacking faults and deformation of the lattice. The separation of these two effects is very difficult. In such instances, method (a), applicable only to f.c.c. materials, is eminently suitable, as broadening due to internal strains does not result in a shift of the peak position. The location of the  $K\alpha_1$  peak of a composite broadened line may be measured accurately by a graphical<sup>7</sup> or an analytical<sup>8</sup> method. It is not satisfactory to compare the peak position with the predicted position because of the systematic errors which influence the apparent peak position in all powder photographs. Instead, the measured separation of adjacent lines may be compared with the corresponding separation in annealed (unfaulted) materials photographed under the same conditions. Reasonable confidence in the interpretation of results is obtained only if several such separations are measured on one film and give the same value of  $\alpha$ .

There is no movement of peak positions in the case of reflections from faulted h.c.p. structures and hence method (a) is not suitable for hexagonal materials. Method (b) is the most usual for these structures and gives reliable results if the line profiles are determined accurately by careful photometering or by Geiger counter methods. Suitable corrections have to be applied, however, for geometrical broadening<sup>9</sup> and for intensity lost in photometering.<sup>2,9</sup> In cases where internal strains also contribute to line-broadening, the systematic variation in integral breadths of lines not affected by faulting must be taken into consideration. The results may again be regarded as satisfactory only if the values of  $\alpha$  obtained from a number of different lines are in reasonable agreement. A further check is obtained if the same specimen is photographed with several different

radiations, so that the geometrical conditions for a given reflection are varied. This check will establish whether or not true diffraction broadening is measured.

Measurement of integrated intensity of a line is necessary, in order to obtain its breadth. Its use in determining  $\alpha$  (Method c) is however purely subsidiary, since measurements of breadth are much more accurate than those of intensity. Moreover, the rate of change of intensity with  $\alpha$  is usually too small for the values of  $\alpha$  encountered in practice.

Method (d), in which the line shape is expressed as a Fourier series,<sup>10</sup> is probably the best way of obtaining the maximum information from any one line. Internal strain and faulting effects can be separated in this method from the relation between successive Fourier coefficients.<sup>9,11,12</sup> Its use becomes very tedious, however, when a number of specimens have to be examined to find the effect of external variables on the amount of faulting. For ordinary work, the measurement of shifts in line peaks and integral breadths seems to be almost as accurate and definitely more convenient, provided all the precautions detailed above are taken.

## CONCLUSION

Interest in the detection and accurate measurement of stacking faults in close-packed metallic lattices has been increasing steadily in recent years as evidenced by the number of papers published on this subject. The importance of work in this fascinating field of research is bound to grow in coming years as the study of stacking faults seems to be closely bound with the development of the theory of dislocations as well as theories of work-hardening.

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# THE PHOTOLYSIS OF URANYL OXALATE AND THE PREPARATION OF URANIUM (IV) OXYOXALATE AND OXALATE

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THE photolysis of uranyl oxalate, on account of its application in actinometry, has been extensively investigated.<sup>1-3</sup> The uranyl ion  $\text{UO}_2^{2+}$  is reduced to the uranium (IV) state with simultaneous oxidation of oxalic acid to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . Both the ionic species  $\text{U}^{4+}$  and  $\text{UO}_2^{2+}$  represent the uranium (IV) state and it is obvious that the former would give the oxalate  $\text{U}(\text{C}_2\text{O}_4)_2$  and the latter the oxyoxalate  $\text{UO}(\text{C}_2\text{O}_4)$ . Thus the formation of the oxalate or the oxyoxalate depends on the conditions of photolysis in which the uranyl ion either reduces to  $\text{U}^{4+}$  or  $\text{UO}_2^{2+}$  ionic state. Uranium (IV) oxalate is obtained as a dark green precipitate when a solution of uranyl salt with oxalic acid is exposed to sunlight.<sup>4</sup> The method of preparation of Marchi<sup>5</sup> of this compound involves the reduction of  $\text{UO}_2^{2+}$  in hot HCl solution by solid sodium thiosulphate. The preparation of uranium (IV) oxyoxalate has not hitherto been reported. Though Büchi<sup>6</sup> found formic acid as one of the products of photolysis of uranyl oxalate, yet no importance was attached to this observation so far as the role of formate ion in the photolysis is concerned. When we exposed a mixture of saturated solution of uranyl formate and oxalic acid in the ratio of 1:6 to

sunlight for 8-10 hours, a dirty green precipitate was obtained. After filtration, the precipitate was washed several times with distilled water and dried in a desiccator for 15-20 hours at the room temperature. The analysis of this compound was carried out as described below and the analytical data recorded in Tables I and II show that the compound is hydrated uranium (IV) oxyoxalate having the formula  $\text{UO}(\text{C}_2\text{O}_4) \cdot 6\text{H}_2\text{O}$ .

The molecular weight was determined from the oxide  $\text{U}_3\text{O}_8$  obtained by heating weighed quantity of the compound in platinum crucible. It was also determined from the total oxidisable content, U(IV) and oxalate ions, which was estimated by titrating solutions of the weighed amounts of the substance in 6N  $\text{H}_2\text{SO}_4$  against standard  $\text{KMnO}_4$  solution. That part by weight which would require 4 litres of N  $\text{KMnO}_4$  solution would represent the molecular weight of the compound. Separate determinations of uranium and oxalate contents were also done; the former by Jones reductor method<sup>7</sup> and the latter by titrating the acidified filtrate, obtained after hydrolysis of the compound in sodium hydroxide, against standard permanganate solution. The analytical data recorded in

TABLE I  
Mol. wt. (theoretical)—450  
Mol. formula:  $\text{UO}(\text{C}_2\text{O}_4) \cdot 6\text{H}_2\text{O}$

Compound taken	$\text{U}_3\text{O}_8$ found	Mol wt. computed	Compound taken	Vol. of N/10 $\text{KMnO}_4$ required	Mol. wt. computed
0.1166	0.0730	448.3	0.1130	10.15	445.6
0.1027	0.0643	448.0	0.1017	9.05	449.6
0.1297	0.0804	453.3	0.1270	11.25	452.4
0.1044	0.0647	452.6	0.1420	12.55	453.6

TABLE II  
Separate estimations of uranium and oxalate contents

Compound taken	U. by J. reductor		Compound taken	Oxalate by $\text{KMnO}_4$	
	Calculated	Found		Calculated	Found
0.0932	0.0492	0.0498	0.1005	0.0197	0.0201
0.1510	0.0798	0.0800	0.1058	0.0207	0.0212
0.1682	0.0889	0.0890	0.1066	0.0208	0.0212
0.1746	0.0923	0.0928	0.1477	0.0289	0.0282



Tables I and II refer to the compound obtained from two preparations and each determination being carried out in duplicate.

When the oxyoxalate was obtained in place of the oxalate  $U(C_2O_4)_2$  as described above, it was evident that the formate ion does play an important role in the mechanism of the photolysis of uranyl oxalate. Our next attempt was to obtain the oxalate by the photolysis of the

the advantage of being used in this laboratory for the separation of uranium in the pure state.

The isolation of these two compounds in the final products of the photolysis of uranyl oxalate in the presence of the formate ion, in our opinion, would be of importance in elucidating the mechanism of the photolysis and in satisfactorily explaining the varying quantum yield

TABLE III  
Mol. wt. (theoretical)—522  
Mol. formula:  $U(C_2O_4)_2 \cdot 6H_2O$

Compound taken	$U_2O_5$ found	Mol. wt. computed	Compound taken	Vol. of N/10 $KMnO_4$ required	Mol. wt. computed
0.1844	0.0985	523.0	0.2512	28.80	523.4
0.1353	0.0729	521.0	0.2198	24.95	528.0
0.1754	0.0944	521.5	0.1188	13.60	524.1
0.1224	0.0660	520.0	0.1073	12.20	527.7

TABLE IV  
Separate estimations of uranium and oxalate contents

Compound taken	U. by J. reductor		Compound taken	Oxalate by $KMnO_4$	
	Calculated	Found		Calculated	Found
0.1736	0.0791	0.0793	0.1673	0.0564	0.0560
0.1620	0.0738	0.0735	0.1556	0.0524	0.0522
0.1633	0.0749	0.0744	0.1150	0.0387	0.0386
0.1212	0.0553	0.0558	0.0883	0.0298	0.0299

same mixture. This was achieved by exposing the mixture to sunlight with equal volume of rectified spirit, when the desired  $U(C_2O_4)_2$  settled down as bright green precipitate. The precipitate was filtered, washed several times with rectified spirit and dried in a vacuum desiccator for 2-3 hours at the room temperature. The analysis of the compound was carried out exactly as described before except that the part by weight which would require 6 litres of  $N.KMnO_4$  solution would represent the molecular weight of the compound. The data recorded in Tables III and IV would show that the compound is  $U(C_2O_4)_2 \cdot 6H_2O$ . The preparation of the oxalate and the oxyoxalate of uranium (IV) by the method described has

which are still in the speculative stage. Further work in the line is proceeding.

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## EIGHTH ANNUAL HIGH ENERGY PHYSICS CONFERENCE AT CERN

**T**HE Eighth High Energy Physics Conference was held this year under the auspices of CERN European Organization for Nuclear Research at Geneva from June 30 to July 5, 1958. This is the first time the Conference was held outside Rochester (U.S.A.) and the 300 and odd participants who attended by invitation represented a truly international gathering.

The Conference held nine sessions which fell into three categories: (1) Nucleon structure and interaction of nucleons with photons, pions, nucleons and anti-nucleons, (2) production and interactions of strange particles, (3) weak interactions including  $\beta$ -decay,  $\pi$ -decay and leptonic decay of strange particles. Very few individual papers were presented and instead rapporteurs were assigned for each subject whose task was to present a summary of all the papers falling under the same title submitted to the Conference. This procedure was very successful leaving ample time for discussion.

Dr. M. Goldhaber of Brookhaven presented an excellent summary on the experimental situation of weak interactions. Following the prediction and verification of non-conservation of parity in  $\beta$ -decay, experimenters have been actively engaged in this field and the summary covered the work done by over 70 workers from forty laboratories. As a result of intensive investigations it has now been established that  $\beta$ -interaction is Vector for Fermi transitions, and Axial Vector for Gamow-Teller transitions. The phase difference between V and A is  $180^\circ \pm 30^\circ$  hence interaction is (V-A). The ratio of  $|C_{GT}|^2$  to  $|C_F|^2$  is  $(1.55 \pm .08)$ . Electron and neutrino (conventionally defined as particles) have negative helicity while positron and anti-neutrino have positive helicity (anti-particles). The results are in agreement with two-component neutrino theory. Time reversal invariance appears to be valid to an accuracy of 10%. Thus some fifty years of experimental research in  $\beta$ -decay has been brought to a conclusion. The theorists have to find answers to these observations, and in particular explain the absence of the  $\beta$ -decay of pion,  $\pi \rightarrow e + \nu$ , as also find some reason for the existence of the  $\mu$ -meson. Some speculations on these problems were presented by Feynman in which one tries to assume that the mass of the electron is all electromagnetic.

Panofsky, Drell and Chew discussed nucleon structure. A great deal of experimental work

has been done in this field in the last few years, particularly at Stanford. The results of these experiments have been analysed to determine the lower limit to the radius outside which conventional quantum electrodynamics is valid. The limit on the radius has been estimated to be  $1/\Lambda \sim 0.3 \times 10^{-13}$  cm. and  $1/\Lambda_0 \sim 0.5 \times 10^{-13}$  cm. for the photon and the electron propagators, respectively. Electron-scattering experiments of Hofstadter give for the proton charge and anomalous magnetic moment r.m.s. radii equal values of  $(0.8 \pm 0.1) \times 10^{-13}$  cm. while for the neutron, they give  $(0 \pm .006) \times 10^{-13}$  cm. for the core or charge radius and for its anomalous moment a radius  $(0.6 \pm .15) \times 10^{-13}$  cm. All the experiments are consistent with a point neutron and a spread out proton charge; this poses difficulties to theorists with regard to charge symmetry in nucleon forces.

Sternberger, Glaser and Kaplon reported on strange particles. Bubble chamber as the detector has been intensively used in the field of high energy particle physics in recent years. The cross-section for  $\Lambda$ -production is  $\pi$ -P collision has been measured from 0.91 to 1.4 BeV/c. Two cases of artificially produced  $\Xi^-$  have been found by Wilson-Powells' group in Berkeley indicating a 1 or 2 microbarns cross-section for 5.3 BeV.  $\pi$ -mesons. Some cases of anti-hyperon production have been reported. A number of tests of parity non-conservation in production and decay processes involving  $\Lambda^0$ ,  $\Sigma^\pm$  and  $\Sigma^0$  have been carried out by Berkeley and Columbia groups. While parity is found to be conserved in production processes, the  $\Lambda^0$ -hyperon being polarized perpendicular to the production plane, it is not conserved in decay processes. Spins of  $\Lambda$  and  $\Sigma$  are found to be  $\frac{1}{2}$  and accurate measurements of their lifetime and Q-values have been made. Cloud chamber events by the M.I.T. group show clearly the  $K_2^0 \rightarrow K_1^0$  transformation, and these are expected to give a measure of  $K_1^0$ ,  $K_2^0$  mass difference.

Preliminary results in star production on nuclear emulsion with the Russian phasotron operating with a beam of 9 BeV. protons were presented by Russian scientists.

In pion scattering, accurate measurements were reported at 91 MeV. by Liverpool, 24.8 MeV. by Rochester and 270-300 MeV. by Russian laboratories, respectively. The signs of  $a_{31}$  and  $a_{13}$  phase shifts are definitely negative. Pro-

Professor Puppi remarked that further accurate measurements were needed on  $(\pi^-, P)$  scattering in 100-150 MeV. region to test the validity of dispersion relations. Using  $\pi^+$  dispersion relations and low energy photo-production data, the pion nucleon coupling constant is found to be  $f^2 = 0.08 \pm 0.01$ , same as that given last year. Single pion photo-production measurements have been extended upto 900 MeV. photon energy at Cornell and Caltech. The  $\pi^+$  and  $\pi^-$  cross-sections show a second pronounced maximum at 700 MeV. This has been interpreted by R. R. Wilson of Cornell to indicate a resonant isobaric state with  $T = \frac{1}{2}$ ,  $J = 3/2$ . The discrepancy between  $\pi^+/\pi^-$  ratio in photo-production from  $D_2$  and the Panofsky ratio still remains, and no evidence for pseudo-scalar, isotopic spin zero  $\pi^-$ -meson, proposed by Baldin to explain this discrepancy, has been found.

Search is continuing for 500 m, particle, reported by Alikhanian two years ago, by six different laboratories using counter, cloud chamber and emulsion techniques. As yet no such particle has been seen in 5,000  $\mu$ -mesons. This would indicate that the frequency given by the Alikhanian experiment is too high by a factor of 20.

Theoretically very little progress was reported and certainly one is waiting for some new idea to get us out of the difficulties of divergent field theories or of the mathematical difficulties of analytic continuation of dispersion integrals. Attempts to approach the problem differently were reported by Heisenberg, A. Bohr, Schwinger and others.

Tata Institute of

G. B. YODH.

Fundamental Research,  
Bombay.

## OBITUARY

### PROFESSOR K. V. GIRI

THE sudden demise of Dr. Giri on July 17, 1958, at Madras, took away from our midst a distinguished biochemist of our country.

Kramadhathi Venkata Giri was born near Madanapalle in 1907. Graduated from the St. Joseph's College, Trichinopoly, he took the M.Sc. Degree of the Calcutta University and then joined the Department of Biochemistry, Indian Institute of Science, Bangalore, in 1929. His early work on "Investigations on Enzymes" gained for him the Degree of Doctor of Science of the Calcutta University in 1938. After two years of service as Enzyme Chemist at the Nutritional Research Laboratories, Coonoor (1939-40) and three years as Gowthami Lecturer and later Reader in Biochemistry at the Andhra University, he returned to the Institute at Bangalore, to become Lecturer in Biochemistry in 1943. He was elevated in 1950 to the Professorial chair in Biochemistry, a post he held till the end. During 1949-50, he was associated with Prof. H. von Euler, at the University of Stockholm, Sweden, and visited Norway,

Denmark and England. He presided over a section of the International Symposium on Enzyme Chemistry held at Tokyo in the fall of 1957.

Dr. Giri's main interest in research was plant biochemistry, particularly the mechanism of synthesis of oligosaccharides and starch in cereals and plants, a field to which he made several notable contributions. However, he was deeply interested in the spread of biochemical education, if only for the study of our abundant vegetable and animal resources. He held the firm conviction that to achieve this end, economical and highly simplified biochemical techniques are necessary prerequisites and he turned, in his characteristic way, his unstinted attention to the introduction of such of his modified techniques as circular paper chromatography and agar electrophoresis. He spared no pains to popularise them through his writings, lectures, radio-talks and visual demonstrations by charts and cine-films.

## LETTERS TO THE EDITOR

## FADING OF RADIO WAVES

WORKING in the Ionospheric Laboratories of the Physics Department of Sri Venkateswara University, Tirupati, the problem of the fading of radio waves was studied, choosing medium wave radio transmissions from Madras (distance = 110 Km.), Tiruchirapalli (distance = 320 Km.) and Delhi (distance = 1,700 Km.). Observations were taken employing a specially designed sensitive R-F amplifier-detector unit. The voltage developed across a resistor placed in the anode circuit of the detector is fed to a sensitive, low period mirror galvanometer. The deflections of the galvanometer are then proportional to the amplitude of the down-coming wave. Galvanometer deflections were noted at intervals of every three seconds for a period of 10 minutes at different times between 19.00 and 23.00 hrs. every day. The variations of galvanometer deflections with time were represented graphically. From such graphs the amplitude

distribution curves were drawn in the usual way<sup>1</sup> for the three stations mentioned above. Following Khastagir and Ray<sup>2</sup> the Rayleigh formula was employed to draw the theoretical distribution curves. The probability  $P(r)dr$  of the amplitude lying between  $r$  and  $(r + dr)$  is given by

$$P(r) dr = \frac{r}{r_m^2} \exp\left(-\frac{r}{2r_m}\right) dr,$$

where  $r_m$  is the most probable amplitude as found from the time-intensity graphs. The three theoretical and experimental curves for the three stations are shown in Fig. 1.

From the figure it is clear that there is a very close agreement between the experimental curves and theoretical distributions for the two near stations (Madras and Tiruchirapalli). This confirms the earlier findings of Pawsey<sup>1</sup> and Khastagir and Ray.<sup>2</sup> For the distant station (Delhi) the experimental curve shows two maxima indicating considerable departure from theoretical expectations. These deviations are being studied and details will be published in due course.

The authors record their sincere thanks to Dr. J. Bhimasenachar, Reader in Physics, for his encouragement and the interest he has been taking in this work.

Physics Department,  
Sri Venkateswara  
University,  
Tirupati, April 10, 1958.

P. VENKATESWARLU.  
R. SATYANARAYANA.

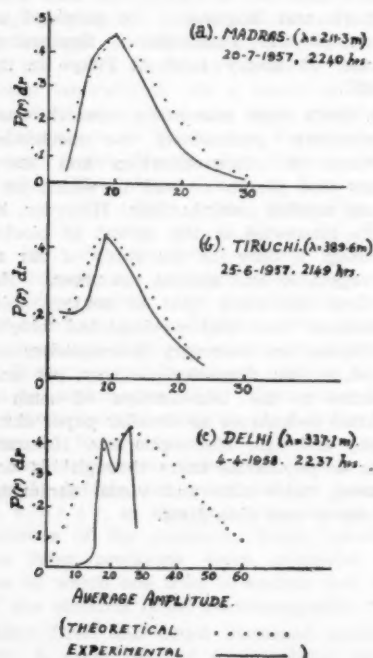


FIG. 1. Amplitude distribution curves.

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MAGNETISM AND MOLECULAR  
STRUCTURE: PROXIMITY EFFECT IN  
ORTHO-SUBSTITUTED BENZOIC ACIDS

FLÜRSCHHEIM<sup>1</sup> first pointed out that all ortho-substituents, even electropositive methyl group, increased the strength of benzoic acid. It has been observed by a number of workers that the properties of substituents attached to the benzene ring are anomalously influenced by ortho-substitution. According to Baddeley<sup>2</sup> many anomalies associated with ortho-substituents can be explained on the basis of steric



hindrance of resonance. Dippy and co-workers<sup>3</sup> have discussed the ortho effect in relation to the strengths of substituted benzoic acids. In the present investigation molar diamagnetic susceptibilities of a few ortho-substituted benzoic acids were measured to see whether it would help to understand the nature of the ortho or the proximity effect.

The apparatus and the method of measurement of magnetic susceptibilities were the same as those described by Angus and co-workers.<sup>4</sup> The results are presented in Table I. All the susceptibility values are expressed in terms of  $-1 \times 10^{-6}$  c.g.s. units. The error of measurement of specific susceptibility ( $\chi$ ) was in no case greater than  $\pm 0.001$ .

TABLE I

Compound	$\chi$	$\chi_M$	$(\chi_{COOH} - \chi_M)$
O-nitrobenzoic acid ..	0.440	73.53	11.72
Nitrobenzene ..	..	61.81 <sup>5</sup>	..
O-chlorobenzoic acid ..	0.534	83.56	12.56
Chlorobenzene ..	..	71.00 <sup>6</sup>	..
O-aminobenzoic acid ..	0.563	77.18	14.81
Aniline ..	..	62.37 <sup>5</sup>	..
O-hydroxy benzoic acid	0.546	75.41	14.51
Phenol ..	..	60.90 <sup>6</sup>	..
O-toluic acid ..	0.594	80.83	15.00
Toluene ..	..	65.83 <sup>5</sup>	..
Phthalic acid ..	0.496	82.39	12.12
Benzoic acid ..	0.576	70.27	15.51
Benzene ..	0.702	54.76	..

Considering that the magnitude of values of  $(\chi_{COOH} - \chi_M)$  in substituted benzoic acids will be influenced by the presence of the ortho-substituents, the extent of departure of this value from that obtained for benzoic acid may be taken as a measure of this influence. Values of  $(\chi_{COOH} - \chi_M)$  were obtained by subtracting molar susceptibility of the appropriate mono-substituted benzene derivative from that of the substituted benzoic acid. These are given in column 4 of Table I. The data on molar susceptibilities of mono-substituted derivatives of benzene required for the purpose were taken from the literature.

The diminishing order of the influence of the groups  $\text{NO}_2 > \text{COOH} > \text{Cl} > \text{OH} > \text{NH}_2 > \text{CH}_3$  is in agreement with the decreasing order of their electronegativities or the inductive effect. This observation suggests that inductive effect is of greater importance than the resonance effect while considering the effects of substituents at short range. It is likely that this may be due to steric inhibition of resonance brought about by destruction of coplanarity. Some kind of suppression of the resonance effect is also

indicated by the fact that contrary to expectation electron-releasing groups like the methyl group which according to Pauling<sup>7</sup> owe their electron-releasing property to the predominance of the resonance effect over the inductive effect, cause a decrease in the value of  $(\chi_{COOH} - \chi_M)$  in the same manner as a strongly electron-attracting group like the nitro-group.

On the basis of the Langevin expression for molar diamagnetic susceptibility, the observed reduction in the value of  $(\chi_{COOH} - \chi_M)$  on introducing an ortho-substituent group in unsubstituted benzoic acid may be attributed to a decrease in electron density around the carboxyl group resulting from the withdrawal of electrons by the ortho-substituents through the inductive mechanism. This is borne out by the fact that the  $(\chi_{COOH} - \chi_M)$  value decreases with an increase in the electronegativities of the ortho-substituents. It may be concluded, therefore, that the existence of the ortho or the proximity effect which was discovered while studying esterification of benzoic acids and their dissociation constants, is also supported by the diamagnetic behaviour of ortho-substituted benzoic acids.

The work described in this article was carried out by the author during the tenure of a Government of India scholarship at the University College of North Wales under the direction of Dr. W. R. Angus.

Chemistry Department, D. D. KHANOLKAR,  
Institute of Science,  
Bombay-1, April 1, 1958.

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#### A METHOD OF ELECTROLYTIC ETCHING OF TANTALUM FOR CAPACITOR USE

THE idea of using tantalum for electrolytic capacitors is not new, but the greatest developments in this field have occurred only recently. Although tantalum is much more costly than aluminium, the dielectric constant of its anodic layer is also about 50% higher than that of aluminium. Further economies can be effected by evolving a suitable etching technique which would increase the surface and thereby the



capacitance. Various attempts, mostly under patents, had been made to evolve a satisfactory technique of etching tantalum but due to its marked inert nature and resistance to corrosion none had been completely successful in finding a simple technique. It is attacked only by concentrated boiling caustic alkalies or by hydro-fluoric acid but both these treatments often embrittle the tantalum foil or wire. A fresh attempt was, therefore, made.

Some initial experiments were made for evolving a suitable electrolytic etching method. Use of organo-halogen compounds was considered most hopeful due to the powerful action of the nascent halogen atoms produced *in situ* during the electrolysis. Various combinations and baths such as aqueous and non-aqueous solutions of bromo-acetic acid, bromine, chlorine, etc., were tried and although under suitable electrolytic conditions, a certain amount of etching could be observed, the results were never very satisfactory as either the magnification was very low or the etch pattern was very irregular and concentrated on some weak points leading to small holes in the foil. However, the use of trichloroacetic acid and methanol as the basic components of the bath gave better results. Another necessary requirement about the bath being insensitive to the presence of small quantities of water and not requiring special purification of the components was also fulfilled. With the use of trichloroacetic acid, it was found that technical methanol could be easily used and that the presence of 0-10% water did not tremendously change the effectiveness of the treatment. However, it was found that even a 5% solution of trichloroacetic acid in methanol did not pass much current during the initial stages of the electrolysis although the bath resistance gradually decreased and the current increased as the etching progressed. In order to avoid this, a small amount of sodium hydroxide was added, forming sodium trichloroacetate *in situ* in the solution. This considerably improved the conductivity of the solution. Satisfactory etching could be obtained in 3-30 minutes in such a bath at a current density of 20-70 mA/cm.<sup>2</sup> of the tantalum foil, the actual values of current density and time depending on the bath composition, the type of etch required and the thickness of tantalum foil used. The temperature used was usually between 20-40° C. Tantalum anodes thus etched showed a regular etch pattern, increasing the surface by as much as 500% or so. Such anodes were then anodised and formed in suitable glycol-borate baths, and assembled when their capaci-

ties showed an effective increase of 300-400%, depending upon the voltage of forming. For example, a tantalum foil, 50  $\mu$  thick, when etched for 15 minutes at 40 mA/cm.<sup>2</sup> and 35° C. in a bath consisting of trichloroacetic acid 5 g., sodium trichloroacetate 1 g. and methanol 100 g. and later formed to 65 V, showed a capacity magnification of 3.8 times over a similar unetched foil. Similarly, as high a capacity rating as 1 Mfd./cm. could be achieved by etching a 1 mm. diameter tantalum wire and forming at 12 V.

A British patent is being obtained and the author has assigned the world rights for the exploitation of this invention to Messrs. British Dielectric Research Limited, London.

April 11, 1958.

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#### PHOTOCHEMICAL PROPERTIES OF NICKEL COMPOUNDS

WHILE nickel compounds are not known to exhibit any marked photochemical properties comparable to compounds of iron, records of a few observations of such activity are to be found in literature. For example, Platonikov<sup>1</sup> reported that the green surface of nickel hydroxide darkened on exposure to light. Baly and co-workers<sup>2</sup> noticed that the green surface of nickel carbonate turned black on prolonged exposure to sunlight. These workers did not, however, attempt to find out the nature of the chemical change involved in this darkening. In the course of a systematic study of the action of sunlight and light from mercury arc, on solutions of nickel nitrate, the present author found that this compound decomposes yielding nickel nitrite, some oxygen and a black solid corresponding to Ni<sub>2</sub>O<sub>3</sub>. The course of the reaction was followed by estimating the nitrite content of the exposed solutions. The photolysis of nickel nitrate, therefore, resembles the photolysis of alkali nitrates,<sup>3</sup> chlorates<sup>4</sup> or perchlorates,<sup>5</sup> which form lower compounds and evolve oxygen. It was further observed that the addition of an acid like acetic acid retarded while addition of some sodium hydroxide accelerated photolysis. Besides, green nickelous oxide formed by the addition of sodium hydroxide to nickel nitrate turned black quickly on exposure to sunlight, or ultraviolet light.

Exposure of nickel hydroxide and nickel carbonate precipitated from solutions of sulphate or chloride, in fact from solutions other than nitrate, chlorate or perchlorate, did not

turn dark on exposure to sunlight. Such precipitates on being mixed with small quantities of nitrate, chlorate or perchlorate, however, turned dark by photo action. It is significant that Baly's experiments were conducted with nickel carbonate precipitated from nickel nitrate. It would thus appear that the darkening of the solids observed by the previous workers was due to the presence of traces of nitrate adhering to the solid particles.

The photolysis of nitrate ion to yield nitrite ion and atomic oxygen, and the combination of atomic oxygen with nickelous oxide to yield nickelic oxide would be the explanation of the phenomena observed in the cases cited.

The full details of this work will be given in a later communication.

The work described in this paper was carried out by the author in the Chemistry Department of Osmania University in 1946, under the guidance of late Dr. M. Qureshi, and formed part of the thesis submitted for the Ph.D. Degree of the University.

Photochemical Laboratory,  
Cambridge Research Centre,  
Boston, Massachusetts,  
U.S.A., April 7, 1958.

K. VEERIAH.

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#### DOUBLE BOND REACTIVITY OF UNSATURATED FATTY ACIDS IN MINERAL FLOTATION

SOAP flotation of non-sulphide minerals has been the subject of study by many workers and the present work is an attempt to find the relative collecting power of some unsaturated fatty acids for the flotation of calcite. The effect of the flotation variables such as the nature of the collector, concentration of the collector and the pH of the medium, on the contact angle of calcite was studied with a view to correlate the collecting power of fatty acids with their degree of unsaturation. The apparatus used for the measurement of contact angles was similar to those employed by Taggart, Taylor and Ince<sup>1</sup> and del Giudice,<sup>2</sup> with some modifications for easier working. Contact angle measurements were made on highly polished calcite crystals (99.7%  $\text{CaCO}_3$ ) collected from a mine near Bhadravati, Mysore State.

Stearic acid, a saturated 18 carbon fatty acid

and three unsaturated 18 carbon fatty acids, namely, oleic, linoleic and linolenic acids containing respectively one, two and three double-bonds in their molecule, were used as collectors, in the form of solutions of their sodium soaps. With each collector, in the concentration range of 5-500 mg. per litre, contact angle was found to increase with increase in concentration, up to a maximum equilibrium value of 60° and thereafter it remained constant. In dilute solutions (5-150 mg. per litre), for the same concentration, linoleic acid gave a larger contact angle than oleic acid and hence the minimum concentration of collector required to give the equilibrium contact angle of 60° was less in the case of linoleic acid than with oleic acid. Linolenic acid gave the same contact angle as linoleic acid. Stearic acid was found to be a poor collector for calcite, inasmuch as it was very difficult to get it adsorbed on the mineral surface to produce a definite contact angle. Hence unsaturated fatty acids are better collectors than saturated ones. Linolenic acid, though having one more double-bond than linoleic acid did not give a higher contact angle than linoleic acid of the same concentration. Hence, as a collector, linolenic acid behaves just like linoleic acid and is in no way better.

Contact angle was found to increase with time until the final equilibrium value was reached. Equilibrium angle was obtained sooner or later depending upon the pH of the collector medium. Hence with a particular collector concentration sufficient to give the maximum contact angle of 60°, the time of attainment of equilibrium was determined at various pH values. This time was found to increase with increase in the pH of the collector. Under identical conditions of collector concentration, pH and temperature, equilibrium was attained quicker in the case of linoleic acid than with oleic acid, the difference being pronounced at higher pH values. In this respect, the behaviour of linolenic acid was the same as that of linoleic acid. Hukki and Vartiainen<sup>3</sup> by vacuumatic cylinder flotation tests on ilmenite, have made certain observations and concluded that the collecting power of fatty acids used in flotation increases with increasing unsaturation of the hydrocarbon chain. This conclusion, however, is not supported by their tests with linolenic acid and this has been attributed to the fact that the linolenic acid used by them was only a 65% concentrate. In the present investigation, a concentrate containing 85% linolenic acid, the rest being mostly

linoleic acid, has been used. Taking into account the percentage purity of the linolenic acid sample used, the collecting power of a solution of pure linoleic acid (sodium soap) was compared with that of a solution of this linolenic acid but of a higher concentration so that the two solutions contained the same number of molecules of linoleic and linolenic acids respectively. Still the collecting action was the same in both the cases.

Recently Sun and others<sup>4</sup> in an investigation on the flotation characteristics of a leached zone aluminiferous phosphate ore, have observed that the collecting power of fatty acids increases with increase in unsaturation of the collector molecule, up to two double bonds only and further increase in the number of double-bonds has no effect. The results of the present investigation lead to the same conclusions as those of Sun and others.

#### ACKNOWLEDGEMENT

The authors are very thankful to Prof. A. A. Krishnan, Head of the Department of Metallurgy, Indian Institute of Science, for his keen interest in this investigation.

Dept. of Metallurgy, R. MALLIKARJUNAN.  
Indian Inst. of Science, V. RAMACHANDRAN.  
Bangalore, April 3, 1958.

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3. Hukki and Vartiainen, *Mining Engg.*, 1953, 5, 818.
4. Sun et al., *Ibid.*, 1957, 9, 70.

#### GEOLOGY OF ADIKMET AREA, HYDERABAD

PRELIMINARY investigations of the Adikmet area indicate that there are two distinct varieties of granites, showing differences in colour, mineral composition, texture and degree of deformation. Megascopically these can be classified into the pink and the gray granites. Considerable variation in grain-size is noticed in both the granites. Pink granites are mostly coarse and porphyritic while among the gray granites the darker rocks are medium- to fine-grained and the paler rocks are coarse and porphyritic. The darker rocks are gneissose in appearance. Small pegmatitic and aplitic veins are numerous. A few basic dykes intrude into these granites. Dark basic inclusions (probably xenoliths) are found both in the pink and the gray types but appear to be more abundant in the gray granites. The distribution of the granites

along with later intrusives is shown in the map (Fig. 1).

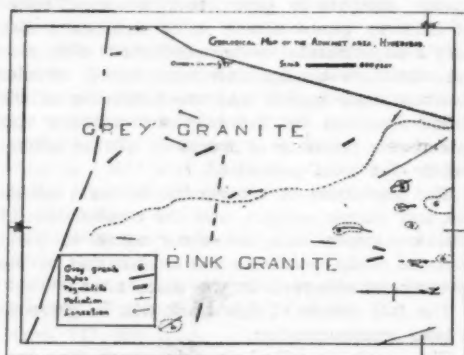


FIG. 1

The boundary between the pink and the gray granites is not very distinct. A few gradational contacts and still fewer sharp contacts have however been observed. At places an intermixture of the two (probably a hybrid type) is seen.

Some of the prominent structural features studied in the area are shown in Fig. 1. A critical study of joint pattern shows that major joints strike in east-west direction. A study of the elasticity and petrofabrics reveals that the gray granites are more deformed than the pink variety. It is interesting to note that the lineation and foliation directions are more or less parallel to the trend of the outcrops.

Further critical studies will be carried out of the larger area in order to bring out the tectonic history of the region.

Osmania University, DR. S. BALAKRISHNA.  
Hyderabad, PROF. PETER E. WOLFE.  
April 4, 1958. N. RAJA.

#### EFFECT OF BLANCHING ON ENZYMIC BROWNING IN GREEN AMARI APPLE

ENZYMIC browning in fruits and vegetables has been studied by numerous workers and has been reviewed by Joslyn and Ponting.<sup>1</sup> In the case of apples of the Green Amari variety, which are used in this country for making preserve, it was of interest to study the rate of destruction of the browning enzymes during blanching prior to treatment with sugar syrup. Apples of this variety were peeled, placed in 2% salt solution and then blanched in boiling water for

2-15 minutes, cooled quickly in cold water and examined for any browning. On cutting the apple into halves either transversely or longitudinally, it was observed that there was a circular crescent-like brown ring demarcating the fruit tissue into two sections in the case of blanching upto 6 minutes, and the area of the brown surface around the pit of the apple decreased with increase in the duration of blanching in the case of 7, 8 and 10 minutes blanch. There was, however, no ring or brown centre in the case of the 15-minutes' blanch thereby indicating complete destruction of the browning enzymes (Fig. 1).

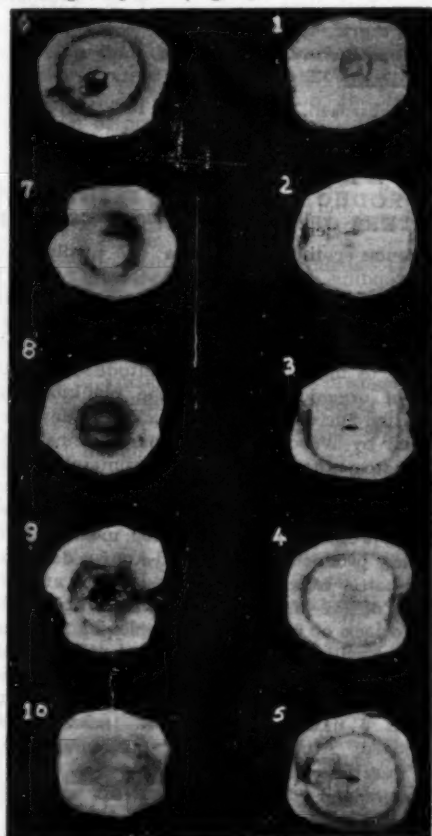


FIG. 1

FIG. 1. Progress of brown ring formation with blanching time in Green Amari apple. Numbers 1-10 represent blanching period of 0, 2, 3, 4, 5, 6, 7, 8, 10 and 15 mins.

In another set of experiments, where peeled whole apple and quarter slices cut transversely, were blanched for 10 minutes, it was observed

that while the slices had not turned brown at all, the whole apple had a markedly brown centre (Fig. 2). There was no further change

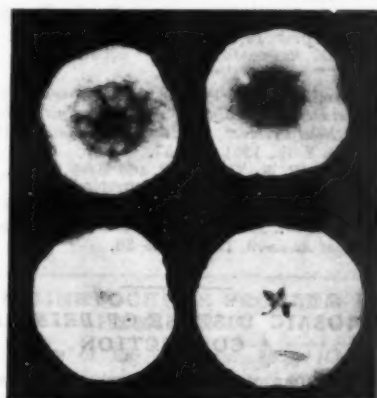


FIG. 2. Browning in whole apple and in cut slices (Blanching time 10 mins.). Top: Slices cut from blanched whole apple; Bottom: Blanched slices.

in the position or area of the brown surfaces in the different sets of blanched apples when they were kept for 12 hours at room temperature of 24-30°C., indicating thereby destruction of enzyme activity. The enzyme is destroyed gradually from the outer periphery towards the centre of the apple with increasing blanching time. The intense browning inside the whole apple may be attributed to the increased and prolonged activity of the enzymes in the partially injured tissue in that region as a result of mild heating, which has been sufficient to injure the cells, but not to inactivate the enzyme system. In the case of the cut slices, however, the heat transfer being over a comparatively much larger area, the enzyme system is quickly inactivated. In the case of peaches, Cruess, Quin and Mrak<sup>2</sup> have stressed the importance of completely heating the fruit to inactivate the enzymes in the interior. Joslyn and Hohl<sup>3</sup> have observed that in scalded fruit browning will occur in the unheated or partially heated areas.

As regards varietal differences, the browning reaction is most marked in Green Amari apple and faint in Golden Delicious, Lal Amari and Kesari varieties. Adequate blanching is essential to prevent any discolouration in sections of the fruit in the final apple preserve.

#### ACKNOWLEDGEMENT

The authors are grateful to Dr. V. Subrahmanyam, Director, and Dr. Girdhari Lal,



Assistant Director, for their keen interest in this work.

Central Food Tech. G. S. SIDDAPPA.  
Research Institute, B. S. BHATIA.  
Mysore, April 19, 1958.

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3. Joslyn, M. A. and Hohl, L. A., *Calif. Agr. Expt. Sta. Bull.*, 1948, 703, 1-108; Seen in *Advances in Food Research*, 1951, 3, 29-30.

### MOSAIC DISEASE OF BRINJAL: A CORRECTION

RAYCHAUDHURI described a mosaic disease of brinjal (*Solanum melongena* Linn.) of widespread occurrence at Delhi and transmissible through grafts and by *Empoasca devastans* Dist.<sup>1</sup> The symptoms described are no doubt of very common occurrence on Brinjal at Poona during winter and *Empoasca devastans* is also found in abundance on these plants. But in carefully planned tests in the glass-house at Poona, large population of the jassid liberated on healthy brinjal seedlings according to the methods described by Raychaudhuri<sup>1</sup> failed to transmit the disease to any of the 21 plants inoculated nor was the disease transmitted to tomato. Since *E. devastans* has not been reported to be a vector of any plant virus disease, Raychaudhuri's<sup>1</sup> findings aroused a doubt about *E. devastans* being a vector of brinjal mosaic. The transmission of brinjal mosaic disease by *E. devastans* was, therefore, reinvestigated both at Poona and Delhi.

A brinjal plant showing typical symptoms of the disease was brought from Delhi to Poona and used for inoculating healthy brinjal seedlings through *Empoasca devastans* from colonies of the jassid on American cotton and brinjal plants. The insects were fed on the source of inoculum for 24 to 72 hours and liberated on healthy test plants for several days. The test plants were afterwards sprayed with Folidol at weekly intervals to prevent building up of jassid populations through the hatching of eggs. The number of jassids liberated on each test plant varied from 20 to 50. Fifty plants were tested in this manner but the disease was not transmitted to any of them. Similar attempts to transmit the disease from mosaic affected brinjal plant to healthy brinjal seed-

lings through *Empoasca devastans* at Delhi also proved unsuccessful.

These results clearly indicate that the disease described by Raychaudhuri<sup>1</sup> is not transmitted by *Empoasca devastans*.

The note is being published to prevent continued mention in literature of *Empoasca devastans* as a vector of mosaic disease of brinjal.

The authors are indebted to Dr. R. S. Vasudeva for suggesting this item of work and for critical scrutiny of the tests.

Division of Mycology & P. M. VARMA.  
Plant Pathology, T. K. NARIANI,  
Indian Agric. Res. Inst.,  
New Delhi, January 18, 1958.

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### A NOTE ON THE ORGANIC PRODUCTION IN THE INSHORE WATERS OF THE GULF OF MANNAR\*

ALTHOUGH considerable data are available on the standing crop of plankton, practically no information is available on the daily production of organic matter in our waters and therefore investigations were started in 1957, with a view to measuring the magnitude of production of organic matter by the plankton algae and its fluctuations. Productivity has been defined by Wood<sup>1</sup> as "light energy transformed by photosynthesis into energy-containing plant material, and this rendered available for further biological use". The technique employed in the present investigation for measuring the primary production is the well-known dark- and clear-bottle experiments. The authors are fully aware of the limitations of this technique but due to lack of facilities for employing the much more sensitive method of using <sup>14</sup>C and also due to the fact that the investigations are conducted in an area where the depth does not exceed 6 metres, the present technique was employed. After a series of preliminary trials the duration of the experiment was fixed at 48 hours and routine measurements were made once a week.

Based on the data available from the experiments conducted so far, the production of organic matter in this area has been calculated and it is found to vary from 0.335 to 1.216 g. C./m.<sup>3</sup> per day. The rate of production appears to be high but it does not seem to be unusual for such areas as the present one because Steemann Nielson and Jensen<sup>2</sup> found during the *Galathea*



TABLE I

Locality	Production	Method employed	Author
Bay of Bengal	0.12 to 0.24 g. C./m. <sup>2</sup> /day	<sup>14</sup> C technique	Steemann Nielsen and Jensen <sup>2</sup>
10 stations in the shallow depth in the Indo-Malayan waters	0.24 to 1.08 g. C./m. <sup>2</sup> /day	do.	do.
Equatorial part of Indian Ocean (Mombasa to Ceylon)	0.13 to 0.47 g. C./m. <sup>2</sup> /day	do.	do.
Sargasso Sea	0.03 g. C./m. <sup>2</sup> /day	O <sub>2</sub> technique	Riley <sup>3</sup>
do.	0.00017 g. C./m. <sup>2</sup> /day (0.043 to 0.058 g. C./m. <sup>2</sup> /day)	<sup>14</sup> C technique	Steemann Nielsen <sup>4</sup>
Long Island Sound	0.04 to 0.25 g. C./m. <sup>2</sup> /day	O <sub>2</sub> technique	Riley <sup>5</sup>
Georges Bank	0.014 to 0.395 g. C./m. <sup>2</sup> /day	do.	do.

Expedition that the rate of organic production anywhere in the tropics in shallow waters is practically high. For comparison the rate of production of organic matter recorded by some of the earlier workers for a few selected areas is given in Table I. The available data further indicate that in the area under investigation, production is usually higher at the lower temperature and salinity ranges.

Concurrent with these experiments, studies are also being made of the standing crop of phytoplankton in terms of chlorophyll, rate of production of diatoms, standing crop of zooplankton and its relation to primary production, rate of grazing, total organic nitrogen and protein nitrogen of the standing crop of plankton. The detailed results of these investigations will be published in due course.

The authors wish to thank Dr. N. K. Panikkar and Dr. S. Jones for encouragement and criticisms.

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V. KRISHNA PILLAI.  
P. V. RAMACHANDRAN NAIR.

Central Marine Fisheries  
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Mandapam Camp, April 8, 1958.

\* Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp, South India.

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## THE KINETOCHORE PROBLEM IN HEMIPTERA

EXAMINATION of the chromosomes of *Orycaenus* sp. (Hemiptera: Heteroptera: Lygaeidae) shows that the kinetochore is localized in this form. Earlier accounts (Menon<sup>1</sup>) of the cytology of this genus mention 17 as the diploid chromosome number in the male, with  $X_1X_2Y$  sex chromosome mechanism. My observations agree with those of Menon regarding the chromosome number (Fig. 1) as also the occa-



FIG. 1. Spermatogonial metaphase showing 17 chromosomes. Most of them show a primary constriction. The three dot-like bodies represent  $X_1X_2Y$ .

FIG. 2. Nucleus in Diakinesis showing two  $m$ -chromosomes (shown in outline). The three dot-like bodies represent  $X_1X_2Y$ .

FIG. 3. Anaphase I with the characteristic 'V'-shaped chromosomes seen clearly.

sional presence of two  $m$ -chromosomes (Fig. 2). But since no information is available in regard to the kinetochore, the present finding of localized kinetochore in the chromosomes of *Orycaenus* is of special interest.

Spermatogonial chromosomes at metaphase show a distinct primary constriction. In anaphase I also this is noticed, especially clearly in the largest chromosomes which are meta-centric (Fig. 3).

Localized kinetochores have been reported in a few other Hemiptera (Pyrrhocoridae: Mendes<sup>2</sup>; Pentatomidae: Dutt<sup>3</sup>; Eurybrachidae: Rao<sup>4</sup>) but this is the first report on a Lygaeid. In view of Piza's<sup>5</sup> observations that the Hemipteran chromosome is dicentric, and the concept of "diffuse centromere" developed by Schrader,<sup>6</sup> Hughes-Schrader<sup>7</sup> and Hughes-Schrader and Ris<sup>8</sup> in this order, it seems possible that more than one condition of the kinetochore exists in this versatile group.

My thanks are due to Prof. B. R. Seshachar for his criticism and encouragement.

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Bangalore, March 25, 1958.

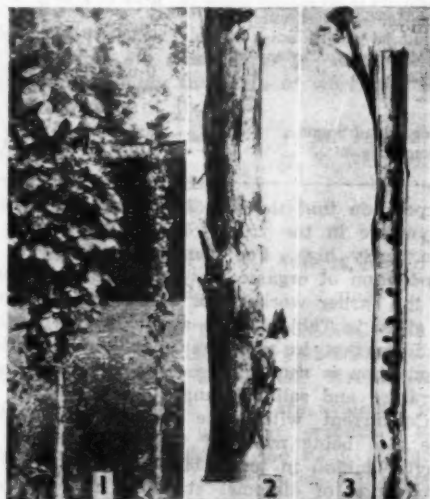
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#### STEM-CANKER, A SCLEROTIAL DISEASE OF HOLLYHOCK (*ALTHAEA ROSEA* CAV.) FROM INDIA

A DISEASE of hollyhock, in which the shoot withered from the apex, was observed in some plants of the Departmental Garden in the first week of January 1951, after a first shower of winter rains. In a number of cases the occurrence of the isolated dried regions in the affected plants was also noted. As the disease spread, nearly 12% of the plants were affected (Fig. 1). On survey the disease was also noticed in several plants growing in other gardens of Lucknow. A number of isolations made from the diseased plants indicated that a strain of *Sclerotinia sclerotiorum* (Lib.) de Bary is associated with the disease, which has only been recorded earlier from America. However, this is a new record for India.

The general symptoms of the disease as observed here agree in main with those described by Young.<sup>1</sup> The epidermis of the dried region shows general browning with some scattered pinkish brown, nearly concentric rings of irregular margins (Fig. 2). The small isolated and raised white pimple-like structures consisting of hyphal tangle and the epidermal cells are developed on the upper layer. The dried parts of the plant, when broken, always separated into fibres. The black rounded or

slender and elongate sclerotia (ranging from 1 or 2 mm. to about  $\frac{3}{4}$ " in length) were abundantly found associated with profuse white fluffy mycelium in the central pith cavity of the affected stem which develops due to the decomposition of the pith cells (Fig. 3). The



FIGS. 1-3. Fig. 1. Healthy and diseased plants. Fig. 2. Cankered area showing irregular concentric zonations,  $\times \frac{1}{4}$ . Fig. 3. Sclerotia in the pith cavity,  $\times \frac{1}{4}$ . region of the pith, in some cases, may also show distinct chambers. The formation of the sclerotia above the epidermis of the cankered region, a feature recorded by Young,<sup>1</sup> has, however, not been observed here even in the advanced stages of the diseased specimens.

The disease appears in 2½-3 months-old plants and occurs isolated rather than in an epidemic form. With the advance of the disease, the leaves, flowers, twigs, and ultimately the entire shoot dries up characteristically. The disease does not manifest itself at the base of the shoot. In those cases where the infection starts in the middle of the plants, the portion above the cankered region dries up after a few days. The roots do not show any disease symptom even in the heavily diseased hollyhock plants.

Forty-five % infection has been achieved, when 3-months-old hollyhock plants specially raised for the purpose in the pots, were experimentally inoculated by putting the blocks of agar bearing the pathogen in the wounds on the stem after proper surface sterilisation and covering it by a piece of cotton wool, periodically moistened with sterile distilled-water for

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a few days in the beginning to avoid drying of the inoculum.

The author is thankful to Prof. S. N. Das-Gupta, for kindly suggesting the problem to investigate and critically going through the paper.

Botany Department, B. B. SHARMA.  
Lucknow University,  
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# VARIATION IN THE PROVENTRICULAR STRUCTURE IN THE COCKROACH *PERIPLANETA* *AMERICANA* (LINN.)

THE proventriculus of the Blattidae is normally short and divisible into a 'proventriculus anterior' armed internally with chitinous plates and a 'proventriculus posterior' containing a circle of six soft, cushion-like lobes with spines and hairs directed backwards. Snodgrass<sup>1</sup> has given a brief description of the proventriculus of the cockroach. Sanford<sup>2</sup> and Eidmann<sup>3</sup> have given detailed account of the proventriculus of Blattidae.

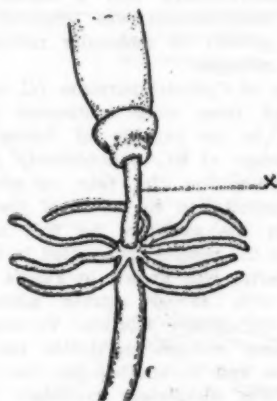


FIG. 1

X indicates the elongated part of proventriculus in the figure. Magnification,  $\times 5$ .

In a fairly appreciable number of specimens of *Periplaneta americana* examined by me, the length of the proventriculus showed considerable variation attaining a length of about 10 mm. in some specimens. This elongation is entirely in the 'proventriculus posterior', i.e., between the 'proventriculus anterior' and the



FIG. 2

oesophageal invagination or the so-called stomodaeal valve. Transverse sections of the elongated portion show the presence of the circle of cushion-like lobes throughout the entire length.

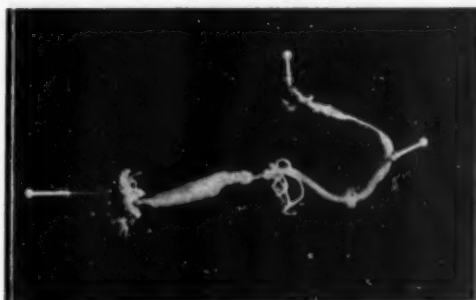


FIG. 3

The proventriculus shows all degrees of development in the various orders and families of insects, but the variation recorded in the present note is interesting as it is confined to a single species. My thanks are due to Prof. R. V. Seshaiya for his help in the preparation of this note.

Dept. of Zoology,  
Annamalai University,  
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April 7, 1958.

N. P. KALYANAM.

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# DEVELOPMENT OF BHC RESISTANCE IN *MUSCA NEBULO* UNDER FIELD CONDITIONS

THERE is no record relating to the development of insecticide resistance in the Indian housefly, *Musca nebulo* under field conditions. As pointed out by Pal *et al.*<sup>2</sup> this may be due to the fact that DDT spraying is usually carried out during the malaria transmission season which does not last for more than 3-6 months, so that if some resistance is developed in this period, it is lost during the rest of the year. Abedi<sup>1</sup> also failed to find any insecticide resistance in flies collected from various localities which had been previously sprayed with DDT for fly control.

A few months back, the authors were informed by public health authorities that flies in some hostels of the University were not killed by routine insecticidal treatments and this led to the observations presented in this paper.

Flies were collected from one of the dining halls of the University where a number of chlorinated insecticides have been sprayed since the last several years. The flies thus collected were reared in the laboratory at 28°C. and four-days-old flies obtained from this parental stock were topically tested with Risella-oil solutions of Lindane. The size of droplet applied was kept constant while the concentration was varied.

TABLE I  
Resistance of *Musca nebulo* to Lindane

Dose	Sex	% Mortality	
		Field collected flies	Laboratory reared normal flies
0.001%	Male ..	70.58	97.36
	Female ..	82.14	86.11
	Average ..	76.36	91.74
0.01%	Male ..	74.60	100
	Female ..	87.69	100
	Average ..	71.15	100

The results obtained (Table I) indicates that *Musca nebulo* has developed insecticide resistance under field conditions. A significant conclusion which can be drawn from these observations is the support to the earlier idea of Pal and his associates<sup>2</sup> that field-resistant strains of *Musca nebulo* are not common because insecticidal operations are usually carried out during malaria transmission season only. In the present case insecticides were regularly

used for fly control during all seasons of the year and thus resistance developed.

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March 22, 1958.

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## THE EFFECT OF MOLYBDENUM ON THE RATE OF GROWTH AND NITRATE ABSORPTION BY *CYLINDRO- SPERMUM SPHAERICA*

EVER since Steinberg<sup>8</sup> showed the important role of molybdenum in the nitrogen metabolism of *Aspergillus*, it has been found that traces of molybdenum are very essential for the maximum growth in a medium containing nitrate as the source of nitrogen.<sup>2,5,7</sup> In the green algae like *Scenedesmus*<sup>1</sup> molybdenum has been found to be indispensable for the assimilation of the nitrate nitrogen. Fogg showed that molybdenum was essential for the nitrogen fixation by *Anabaena cylindrica*, since only very little growth occurred in the absence of supplied molybdenum and a higher concentration of molybdenum was required for the maximum growth on molecular nitrogen than on nitrate nitrogen.

A species of *Cylindrospermum* (*C. sphaerica*) was isolated from some cultivated soils and was found to be capable of fixing nitrogen (Venkataraman *et al.*, unpublished). The role of molybdenum on the rate of growth and nitrogen assimilation in terms of the residual nitrogen in the medium, by this alga, was studied and the results are plotted in Graph I.

The material was grown in Fogg's medium<sup>3</sup> provided with 25 mg. nitrate nitrogen per 100 ml. of the culture solution. To one set was added 0.4 mg. sodium molybdate per litre of the solution and in another set, the molybdenum salt was completely excluded. Both the rate of growth in terms of dry weight, and the nitrogen absorption in terms of the residual nitrogen in the medium were estimated at an interval of four days. The results are the averages of triplicates. All the cultures were kept under constant illumination provided by a 200 watts filament lamp placed at a distance of about 3'. The nitrogen estimations were done by the conventional micro-kjeldahl method.



It is observed that in the medium without any added molybdenum there was practically no growth, and after eight days the material got bleached. In the medium with higher concentration of molybdenum (0.4 mg./l.) there was a steady increase in the rate of growth while, in the molybdenum-deficient medium (0.1 mg./l.) the growth was not only poor as compared with the other set, but also showed a decrease after 16 days. Besides, the molybdenum deficient material assumed a pale yellow green colour. This 'yellowing' may, probably, be due to the reduction in the phyco-cyanin pigment.<sup>4</sup> The complete failure in growth without any added molybdenum shows the importance of this element. 0.1 mg. of molybdenum salt was found to be sufficient up to the sixteenth day, but proved to be a limiting factor for growth afterwards. 0.4 mg. was fully adequate for efficient growth throughout the experimental period.

The nitrate assimilation, on the other hand, does not seem to be markedly affected by molybdenum concentrations within the limits examined. In both deficient and high molybdenum cultures, there is a gradual uptake of nitrate as the alga grows, as seen by the decreasing concentration of the nitrogen in the medium (Graph I, curves B, B'), although the

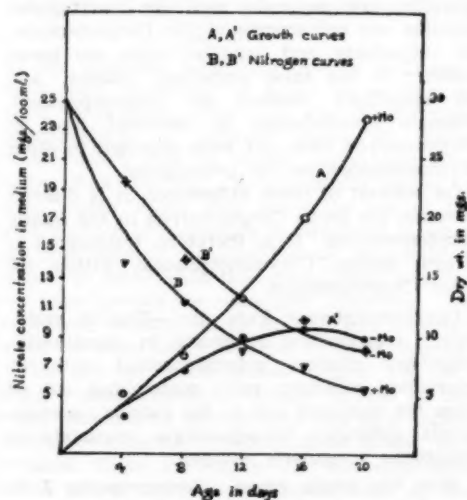
growth and uptake of nitrate were followed in normal and molybdenum-deficient cultures.<sup>2</sup> In the green algae, it has been found that the function of molybdenum is confined to nitrate reduction.<sup>1</sup> There is no conclusive evidence that the fixation of molecular nitrogen by the Blue-green algae involves the formation and subsequent reduction of nitrate.<sup>10</sup> It is seen that addition of molybdenum to the molybdenum deficient cultures provided with nitrate, enhanced the nitrate absorption, a probable consequence of the increased growth of the alga stimulated by molybdenum.

From the above study it appears that molybdenum, within the limits investigated, does not seem to affect appreciably the rate of nitrate absorption by the alga inasmuch as it affects its rate of growth. This is in conformity with the observations in the higher plants,<sup>6</sup> yeast,<sup>9</sup> and *Anabaena cylindrica*.<sup>2</sup>

I am thankful to Dr. M. S. Randhawa and Dr. B. P. Pal for their keen interest and encouragements. I am highly grateful to Dr. S. M. Sikka for his valuable suggestions during the investigation. My thanks are also due to the authorities of the Chemistry Division, I.A.R.I., for facilities to carry out the chemical part of the work.

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March 24, 1958.

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GRAPH I

rate of absorption seems to be more in the high molybdenum cultures which is accountable by the increased growth of the alga in the medium. Similar results have been obtained in *Anabaena cylindrica* also, where the

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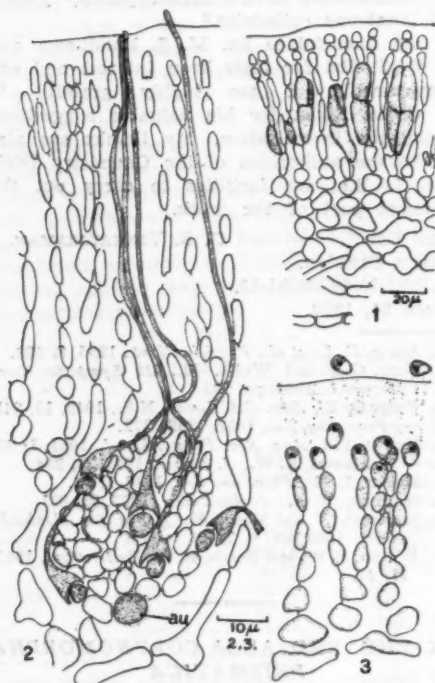
#### ON THE RED ALGA *CORYNOMORPHA PRISMATICA*

THE genus *Corynomorpha* was established by J. G. Agardh<sup>1</sup> in 1872 with two species, *C. prismatica* (J.Ag.) J.Ag. (the type) and *C. clavata* (Harvey) J.Ag., both of which had been previously included under the genus *Acrotylus* J.Ag. *C. prismatica* was based on a specimen collected by Wight from the Indian coast. The alga occurs in abundance at Cape Comorin, S. India,<sup>2</sup> and is also known from Ceylon,<sup>3</sup> E. Africa and Indonesia.<sup>4</sup> Its vegetative organisation has been



well described by Boergesen,<sup>2</sup> but details of reproduction are not fully known. According to the original description, the cystocarps are small and sunken in the spongy, swollen, nemathecoid tips. Tetrasporangia and spermatangia have not so far been observed. Fertile material of the alga was collected by Prof. M. O. P. Iyengar in March 1954, and again by the writer in October 1957. A study of the material revealed a number of interesting features regarding its reproductive structures. A brief outline of these is given here.

The sexual and asexual reproductive structures are borne in nemathecia developed in the younger portions a little below the tip. The nemathecium cover the entire circumference of the fertile regions, which as a result appear swollen. The sexual plants are dioecious.



FIGS. 1-3

A section of the male nemathecium shows that the spermatangial mother-cells are terminal on short unbranched nemathecium filaments. The spermatangia are cut off in basipetal succession from the tips of the spermatangial mother-cells and are catenate, as many as four often being found in a chain (Fig. 3).

The fertile tips of female plants are much more swollen than those of the male plants. The carpogonia are formed in ampullary clusters which are developed laterally from the nemathecium filaments. Each ampullary cluster contains an intercalary auxiliary cell (Fig. 2, au) and a number of two-celled carpogonial branches.

The gonimoblast initial is cut off from the auxiliary cell towards the outside. The numerous small cystocarps are totally immersed in the much swollen nemathecoid tips.

The tetrasporangial nemathecium first occur similarly a little below the tips, but later on cover a larger area than do the sexual nemathecium. The tetrasporangia are short, one-celled lateral branches of the nemathecium filaments, and are in general cruciately divided (Fig. 1), though variations from typically cruciate to more or less zonate conditions are also seen.

The alga is at present included in the Cryptonemiaceae. But, it shows several features which are definitely at variance with what is known regarding reproductive structures in the Cryptonemiaceae.<sup>5-13</sup> In the Cryptonemiaceae so far investigated only tetrasporangial nemathecium are known; in *Corynomorpha* all reproductive structures are borne in nemathecium. Again, in the Cryptonemiaceae, carpogonial and auxiliary ampullae are separate and the carpogonial ampullae are unicarpogonial; in *Corynomorpha*, the carpogonia and auxiliary cells are borne together in the same ampullary cluster, and the ampullary clusters are polycarpogonial. Catenate spermatangia as observed now in *Corynomorpha* have not been reported in other Cryptonemiaceae so far investigated.

On account of these differences, it is difficult to retain the genus *Corynomorpha* in the family Cryptonemiaceae. It is, therefore, transferred to a new family, Corynomorphaceae, within the order Cryptonemiales.

**Corynomorphaceae** Fam. nov.—Thallus multi-axial; reproductive structures in nemathecium; ampullary clusters polycarpogonial with an intercalary auxiliary cell; gonimoblast cut off from the auxiliary cell to the outside; spermatangia catenate; tetrasporangia cruciately or sometimes irregularly divided.

With the single genus: *Corynomorpha* J. G. Agardh (type species: *C. prismatica*).

It may perhaps be mentioned that the new family Corynomorphaceae resembles the Endocodiaceae in some of its features. But, the thallus in *Corynomorpha* is multi-axial, whereas in the Endocodiaceae it is uniaxial.

The second species of *Corynomorpha*, *C. clavata*, has not so far been investigated in any detail. It has been reported only from Florida.<sup>14</sup>

The writer is highly indebted to Prof. M. O. P. Iyengar and Prof. T. S. Sadasivan for encouragement and to Dr. T. V. Desikachary for helpful and critical discussion.

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Madras-5, April 1958.

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## INSECT INCIDENCE AND BRANCHING IN RICE

In rice, normally each culm bears a single ear-head and branching at nodes is exceptional. Some deep-water rices have the characteristic predisposition to produce stems at higher nodes, which may be rightly called branching rather than tillering.<sup>1</sup> Tillers usually spring up from higher nodes also, when the age of the seedlings for transplanting is advanced or when the crop lodges.<sup>2</sup> In some Palmæ, branching is known to occur when the central shoot is killed by borer-beetles or damaged otherwise. In sugarcane, axillary shoots develop into branches when the main shoot dies due to borer damage.

The gall-fly, *Pachytiplosis oryzae* (W. M.) Mani, causes extensive damage to rice as the tillers attacked by gall-fly turn into long hollow tubular outgrowths known as silver shoots. The attacked tillers eventually die but subsidiary tillers spring up from the basal node of the seedling near the surface of the soil, which is the tillering zone.

In a large number of investigations at Cuttack, it has been observed that the percentage incidence of gall-fly is more in the 90-days-old crop than in the 60-days-old crop and the peak

of infestation fluctuates between the end of August to the end of November.<sup>3</sup> Hence certain early-maturing varieties (*Beali*) grown in June to September are generally found to escape infestation by this pest. But, in some late-maturing varieties, especially GEB 24 and Jelly 175, when the crop is about 120 days old, many tillers possess branches, arising from the third or fourth node from the bottom. In all such cases, the main tiller is found to have formed into a silver shoot and the axillary bud, usually from the node just below the silver shoot in that tiller, develops into a branch giving the appearance of the main tiller in effect. This branched tiller develops normally, producing an earhead (Fig. 1). It has also been observed

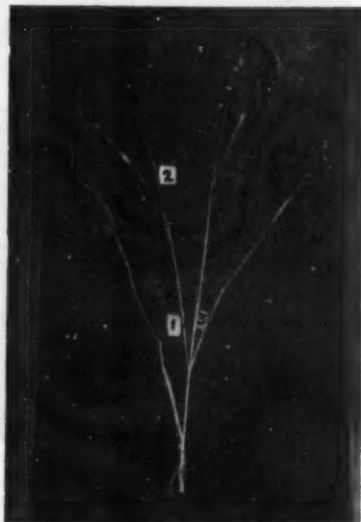


FIG. 1

1. Main tiller formed into a silver shoot due to gall-fly attack; 2. Silver shoot; 3. Branched tiller producing a grain-bearing earhead.

in some cases that the branched tiller is again attacked by gall-fly resulting in another silver shoot and the axillary bud on the main shoot from the node just below the silver shoot develops to form a branch. Very rarely, the axillary buds in two successive nodes below the main silver shoot develop into two branches, even when the first-branched tiller is not attacked by gall-fly.

Similar type of branching is also observed to occur at the shot-blade stage due to the damage caused by stem-borer, *Schaenobius incertulas* Walk. The attacked tillers produce chaffy

grains and are known as white earheads. Stem-borer larva gains entry into the stem by cutting a hole just above or below the second node from the top. If the hole through which the larva enters is just above the second node from the top, the axillary bud in the second node develops into a branch. But should the hole be just below the second node, the axillary bud from the third node from the top develops into a branch. In this case also, the branch produces an earhead but it usually remains green and unset at the time of harvest (Fig. 2).



FIG. 2

1. Main tiller with a white earhead due to stem-borer attack; 2-3. Branched tillers bearing earheads with unset grains.

due to gall-fly incidence. Some of these were later attacked by stem-borer on account of which the earheads of the branched tillers became chaffy. In this case also a branch was noticed to arise from the node just below the stem-borer hole resulting in an earhead. These observations are of importance in assessing the loss caused by the two pests, gall-fly and stem-borers.

In order to estimate the extent of compensation in yield, as contributed by the earheads of branched tillers, differences in the earhead length and the number of sound grains between the normal earheads and earheads of the branched tillers due to gall-fly, were examined in a large number of samples and the data is given in Table I.

It can be seen from the table that the earheads produced by branched tillers are smaller in length with fewer sound grains. The mean weight of grains is significantly more in earheads of branched tillers, probably because the number of sound grains being fewer, they are heavier. It is clear that the branched earheads do compensate loss in yield and in the above case, this compensation is found to be 63.7%. In estimating the loss due to gall-fly, it is important to take this fact into consideration.

The authors' grateful thanks are due to Dr. N. Parthasarathy, for the interest taken in the work.

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G. VEDA MOORTHY.

January 31, 1958.

TABLE I

		Mean earhead length in cm.	Mean No. of sound grains per earhead	Percentage unfilled grains per earhead	Mean wt. of sound grains per earhead in gm.	Mean wt. of 125 grains in gm.
Normal tiller	..	27.78*	136.24*	13.07	2.48*	2.251
Branched tiller	..	23.28	84.48	13.21	1.58	2.347*
Standard Error of difference		0.8765	11.61	2.094	0.217	0.00902

\* Significant at 1% level.

In the main crop season in 1955 (June-December), both gall-fly and stem-borers were prevalent during the middle of October when the following interesting phenomenon was observed. In the varieties GEB 24 and Jelly 175, branching as described above, was observed

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# CHROMOSOMES OF THREE SPECIES OF SOUTH INDIAN PULMONATE SNAILS OF THE GENUS *CRYPTOZOONA* MORCH.

THE number of Molluscs whose chromosomes have been studied is about 135. Of these, 80 are Pulmonates, which do not include any of the Indian species. I have been investigating the chromosomes of South Indian Pulmonates and the present note relates to the chromosomes of the three species of common garden snails,

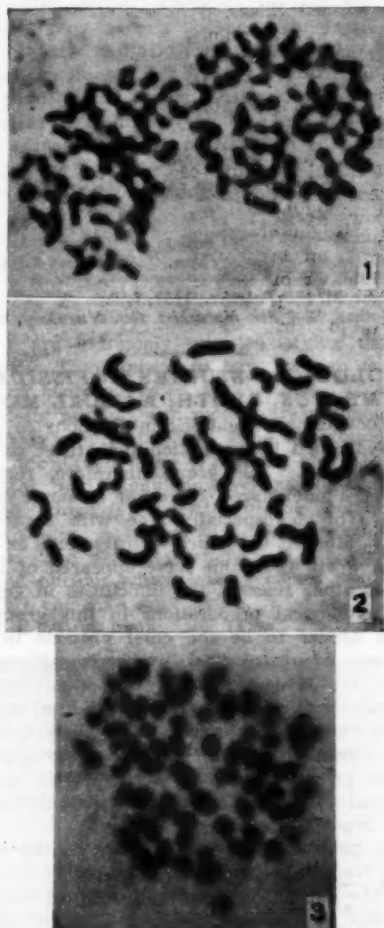


FIG. 1. Polar views of two spermatogonial metaphase plates—photomicrograph—acetocarmine squash—*Cryptozona bistrialis*,  $\times$  ca 4,000. FIG. 2. Photomicrograph of pro-metaphase stage of *Cryptozona semirugata*—acetocarmine squash,  $\times$  ca 4,000. FIG. 3. Photomicrograph of spermatogonial metaphase plate of *Cryptozona ligulata*—polar view—acetocarmine squash,  $\times$  ca 4,000.

*Cryptozona* (*Xestina*) *bistrialis* Beck., *Cryptozona* (*Nilgiria*) *semirugata* Beck. and *Cryptozona ligulata* Fer., formerly known as *Ariophanta bistrialis* Beck., *Ariophanta semirugata* Beck., and *Ariophanta ligulata* Fer. respectively. The chromosomes were studied mainly from acetocarmine and Feulgen squashes.

*Cryptozona bistrialis*.—The number of chromosomes as determined from a study of a number of spermatogonial metaphase plates is  $2n = 54$ . A polar view of two such plates is shown in Fig. 1. All the 54 chromosomes are metacentrics and appear distinctly two-armed, with median centromeres. Six chromosomes are larger in size while the rest are uniform in size and shape.

*Cryptozona semirugata*.—The diploid chromosome number of this form is 56 and a clear preparation of a prometaphase stage is shown in Fig. 2. All the chromosomes are metacentrics and can be grouped serially in pairs in order of their size as follows:—

- (i) One pair of large chromosomes with submedian centromeres.
- (ii) Three pairs of large chromosomes with median centromeres, and
- (iii) Twenty-four pairs of small chromosomes, uniform in size, with median centromeres.

*Cryptozona ligulata*.—A polar view of the spermatogonial metaphase plate (Fig. 3) shows 64 chromosomes—all metacentrics. They resolve into 32 homologous pairs, of which 4 pairs are large and the rest are smaller and uniform in size and shape. Of the four larger pairs, two pairs of chromosomes possess submedian centromeres. The other two larger pairs and also the 28 pairs of small chromosomes have median centromeres.

Table I shows the chief differences between the chromosomes of the three species.

TABLE I

No.	Name of species	Diploid chromosome number	Big chromosomes		Small chromosomes
			Submedian centromere	Median centromere	Median centromere
1	<i>Cryptozona bistrialis</i>	54	6	..	48
2	<i>Cryptozona semirugata</i>	56	6	2	48
3	<i>Cryptozona ligulata</i>	64	4	4	56

Forty-eight, fifty-four, fifty-six and fifty-eight are the commonly occurring diploid



chromosome numbers in Helicidae and the highest number reported so far in Pulmonates is 62, in *Polygyra appressa* by Pennypacker (1930) (cited by Makino<sup>1</sup>) and in *Tridopsis fraudulentula* by Husted and Burch<sup>2</sup> (1946). In the present study, it has been found that *Cryptozona ligulata* has  $2n = 64$  the highest number to be recorded so far.

I have great pleasure in expressing my sincere thanks to Professor R. V. Seshaiya, Head of the Department of Zoology, Annamalai University, for suggesting the problem and also for guidance and help. To the Ministry of Education, Government of India, my thanks are due for the award of a Senior Scholarship.

Department of Zoology, R. NATARAJAN.  
Annamalai University,  
Annamalainagar P.O., April 9, 1958.

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#### CYCADOPTERIS sp. FROM THE RAJMAHAL HILLS, BIHAR

THE first report, from India, of *Cycadopteris* sp. was made by Bose (1957) from Bansa, South Rewa Gondwana Basin. Two more fragmentary specimens of *Cycadopteris* have now been noticed by the author in a collection of fossil plants made by Dr. S. C. D. Sah in 1955, near the village Chunakhal ( $25^{\circ} 13' 30'' N$ ;  $87^{\circ} 79' 52''$ ), Rajmahal Hills, Bihar. Both the specimens are in the form of impressions and are too incomplete to have a specific name. So they are described as *Cycadopteris* sp.

*Cycadopteris* sp. (Fig. 1).—Leaf incomplete, pinnate about 1 cm. broad. Pinnæ attached to a fairly thick rachis, closely set and not over-



FIG. 1. *Cycadopteris* sp., no. 29733,  $\times 2$ .

lapping; obovate; apex rounded; base truncate; margin revolute. Median vein faintly marked, secondary veins also visible.

Locality: Chunakhal.

Age and Horizon: Jurassic, Rajmahal series.

Collection: Specimen No. 29733 of Birbal Sahni Institute of Palaeobotany Museum.

The present specimens differ from *Cycadopteris* sp. described by Bose (1957) in having shorter and broader pinnæ attached to a fairly thick rachis; here both median and secondary veins are present, whereas, in the latter the rachis is slender and the median vein alone is visible. Like *C. anglica* Gothan (1914) and *C. zeileri* Antevs (1915), the present species do not have the turned-under flange over the midrib and the secondary vein. The shape of the pinnæ is different in our specimen.

Birbal Sahni Institute of M. N. Bose.

Palaeobotany,  
Lucknow, April 11, 1958.

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#### CYTOLOGICAL STUDIES IN *FISSIDENS* *ELIMBATUS*, BROTH, A LOCAL MOSS

CYTOLOGICAL investigations in Bryophytes have received much less attention than those on the higher plants. This group, therefore, remains an almost unexplored source of research materials.<sup>1</sup> This is especially true with regard to Indian Mosses in which hardly one or two papers worth the name have appeared of late.<sup>2</sup> Besides other reasons, the difficulties in getting good cytological preparations in this group of plants appear to be the chief obstacle in the progress of cytological research. However, efforts are being made in this laboratory to undertake cytological studies of the local mosses with a view to throw light on the cyto-taxonomical aspect of different genera. A preliminary account of the cytological work done in one of the local moss species, *Fissidens elimbatus*, is being reported here.

This moss *F. elimbatus* appears on the bank of the Ganges in the months of October-December. The capsules appear in November-December. For cytological studies, patches of plants were brought to the laboratory and capsules were squashed in propionic orcein which gave much better results than other stains of this group. Division stages were found in the morning between 10-12 A.M. Studies were made from temporary slides and their microphotographs.



The chromosome number of the species as determined in meiotic stages was  $2n=12$ . Mitotic plates obtained from the wall cells of the capsule also showed 12 chromosomes (Fig. 1) at the metaphase plates. The chromo-

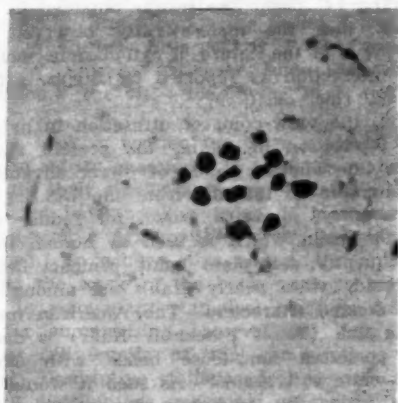


FIG. 1. *F. elimbatus*, microphotograph showing 12 chromosomes at mitotic metaphase  $\times 1,900$ .

somes are extremely minute defying detailed analysis. They appear to have median or sub-median centromeres.

Meiotic prophase in mosses are unfavourable for study at present. The same was found true with the Liverworts.<sup>1</sup> Prophase stages earlier or later than pachytene have rarely been observed, which is suggestive of the shortness of these stages. A typical diakinesis has not been found. The earliest prophase is the centrally located nucleus which later becomes vacuolated making ring-like appearance.

At the first metaphase (Figs. 2 and 3), the



FIG. 2. *F. elimbatus*, microphotograph showing bivalents at I meiotic metaphase,  $\times 2,800$ .

six bivalents are oriented at the centre of the spindle. One of the bivalent is suggestive of



FIG. 3. *F. elimbatus*, camera-lucida diagram of the plate in fig. 2,  $\times 2,800$

sex chromosomes, being feebly stained and larger in size. The anaphase I is quite normal (Fig. 4). At anaphase, the chromatids of biva-



FIG. 4. *F. elimbatus*, camera-lucida diagram of the I meiotic anaphase,  $\times 2,000$ .

lents do not seem to separate from each other. The separation of chromatids at II anaphase with rigidly elongated structure is characteristic.

Cytokinesis leading to tetrad formation takes place only after the completion of the second meiotic division.

The chromosome numbers of some of the species of *Fissidens*, which have been reported before, show variation; namely, *F. elimbatus*,  $n=5$ , and *F. pauperculus*,  $n=12^4$ ; *F. cristatus*,  $n=16$ , *F. cristatus* var. *minor*,  $n=16$ , and *F. japonicus*,  $n=16^5$ .

In the case of *F. elimbatus* it is  $n=6$ . If 5 is the basic chromosome number as reported

in the case of *F. limbatus*, the genus *Fissidens* appears to show a polyploid range. We propose to give a more detailed account of the karyotype study of the different local species later.

Botany Dept.,  
Patna University,  
Patna, March 18, 1958.

R. P. ROY.  
M. K. JAIPURIAR.

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### CYTOPLASMIC MALE STERILITY IN JOWAR (*SORGHUM VULGARE* PERS.)

In the jowar (*Sorghum vulgare* Pers.) culture, I.C. 2360, grown in this Division in 1955, a sterile-looking plant was located. The single ear produced by this plant bore only a few grains; microscopic test for pollen fertility, using the stain acetocarmine, revealed that the pollen was totally sterile. The plant was sibbed, using pollen from a normal, fertile plant belonging to the same culture. The progeny, raised in 1956 from this sibbed seed, was found to be completely male-sterile. These male-sterile plants were again sibbed, using pollen from fertile plants of the parent culture (I.C. 2360); all the 25 plants, grown from this seed in 1957, were again completely male-sterile. This indicated that the male-sterility exhibited by this line was cytoplasmic. The line is now being crossed with a number of distinct genotypes with a view to locating those which would restore fertility as well as those which, like I.C. 2360, would perpetuate sterility.

Stephens and Holland (1954) reported from Texas (U.S.A.) cytoplasmic male-sterility in jowar; this type of sterility is conditioned by

the interaction between nuclear and cytoplasmic factors. The American male-sterile line, together with its fertile counterpart, is being maintained in this Division and has been utilised in crossing with a number of Indian forms, including I.C. 2360. The results obtained so far suggest that the male-sterility observed in I.C. 2360 is of the nature of cytoplasmic-nuclear gene interaction as reported by Stephens and Holland (loc. cit.).

From the view-point of utilisation in hybrid seed production in India, the present male-sterile line appears to be of direct advantage as compared to the one from the U.S.A. In this country, jowar is grown for fodder and also for grain which is used as human food. Consequently, tall plant habit, compact heads, and bold, white pearly grains are among the most desired characters. The American male-sterile line (Texas Blackhull Kafir) is dwarf and possesses semi-loose heads with small, dirty-white soft grains. As such it would require a lengthy backcross programme to be used for hybrid seed production. The present male-sterile line, on the other hand, can be utilised directly as it possesses almost all the desired features.

Male-sterility conditioned entirely by nuclear genes has been reported in jowar both in the U.S.A. (Stephens, 1937) and in India (Ayyangar and Ponnaiya, 1936; Kajjari and Chavan, 1953). It is, however, not so feasible to use such male-steriles for hybrid seed production for which cytoplasmic male-sterility is the best answer. The present report constitutes the first record of cytoplasmic male-sterility in jowar in India.

Division of Botany, S. P. MITAL.  
Indian Agric. Res. Inst., VISHNU SWARUP.  
New Delhi, April 21, 1958. A. B. JOSHI.

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### BORON ROCKET FUELS

UNIVERSITY of Michigan chemists have been working since 1952 on the "ground rules" for the development of the new high energy boron rocket fuels.

Boron fuels have recently been identified as one of this country's major new rocket propellants. Boron compounds are made up of relatively light elements which release far more

energy than conventional petroleum fuels when they burn, providing as much as one and one-half or two times as much thrust per pound. Many of the boron-hydrogen compounds are unstable materials which have had to be "tamed" before they could be put to work as practical fuels.

## REVIEWS

**Statistics for the Social Sciences.** (*An Introduction to Statistics for the Social Sciences.*) Second Edition. Enlarged by T. G. Connolly and W. Sluckin. (Cleaver-Hume Press Ltd., London.) Pp. viii + 166. Price 16 sh. net.

"The book is written for those students who have to satisfy examiners in statistics and also need for their studies a degree of statistical insight, yet have no knowledge of Mathematics beyond simple Arithmetic"—(from the author's preface). To achieve this object, the authors restrict the scope of the book, perhaps justifiably, to elementary statistical methods essential for summarising observational data and present full details of the computations involved. Descriptive statistics dealing with frequency distributions, measures of central tendency and variability, ogive, the normal distribution curve and correlation is covered in the first five chapters and partially in Chapters IX and X. The inference part of statistics of arguing from a sample is treated in the other chapters. The ideas of sampling, reliability of estimates and testing of hypotheses have been explained in a simple manner and the beginner may not have much difficulty in following them. The last chapter (XI) on the analysis of variance is a welcome addition in the second edition of the book. The detailed computational layouts for evaluating the statistical measures will be very useful to statistical computers.

A few comments by way of criticism are called for. No warning is given, anywhere, about the pitfalls in the application of statistical methods to sociological and psychological data. This could have been done by proper choice of examples and explanations as to the suitability of particular methods employed. There is some confusion caused by the use of the same notation for sample estimates as well as for the population constants. The reference to  $t$  table in setting up the confidence limits to  $\sigma$ , the population standard deviation as indicated on page 96 is not a correct procedure. The chi-square test for goodness of fit of a normal distribution discussed on pages 116-17 is different from the one generally used. Perhaps the usual method of comparing the observed frequencies with the expected instead of the ordinates is more appropriate.

C. R. RAO.

**Structure Reports.** Vol. XV. Editor: A. J. C. Wilson; Section Editors: N. C. Baenziger, J. Wyart, J. M. Robertson. (Published by the International Union of Crystallography by N. V. Oosthoek's Uitgevers, MLJ, Domstraat 1-3, UTRECHT), 1951. Pp. viii + 588. Price \$ 29.00.

This volume of structure reports is divided into three sections, namely, Metals, Inorganic Compounds and Organic Compounds. In Metals Section, the arrangement is alphabetical, while in the other two Sections, it is according to the increasing complexity of composition; related substances and related structures have however been kept together as far as possible.

The increasing interest in the properties of metals and alloys in recent years have resulted in a phenomenal growth of the subject from the structural point of view. Transformation in metals, of Martensitic as well as diffusion induced slow type, order-disorder phenomena and precipitation hardening in alloys and their relationships to their thermal history composition, etc., and interesting magnetic properties of certain alloys have led to the search for their ultimate cause which in turn is intimately connected with their structure.

Section I is one of the most interesting part containing valuable data and discussions for over one hundred and eighty metals and alloys.

Section II devoted to Inorganic Compounds abounds in the wealth of material presented. Particular mention may be made of oxides and double-oxides, which include substances exhibiting very interesting properties such as spinels, some titanates and niobates noted for their magnetic and ferroelectric properties respectively. A vast number of mineral structures of varying complexity have been reported, and among them particular mention may be made of tourmalines. A large number of examples of the phenomenon known as epitaxy, that is, the crystal overgrowth on crystals have been presented. Electron diffraction studies have been particularly helpful in the study of overgrowths.

The versatility of carbon in its power to combine readily with itself and with other elements and groups has resulted in millions of compounds being synthesised and identified in nature. Crystallographers have taken to these compounds in spite of their complexity, and we

find today that increasing number of them turning their attention to the solution of organic structure of extreme complexity such as proteins and other biological products. As a result of these investigations in this field, diffraction by helical structures and cylindrical lattices have been developed.

Section III reflects the popularity of organic compounds among crystallographers and contains valuable data for a vast number of organic compounds, from simple aliphatic, aromatic cyclic, and heterocyclic compounds to complex proteins.

The volume is an invaluable reference book, not only to workers who are directly concerned with structure analysis and physical metallurgists, but also to physicists and chemists. The volume has abstracted profusely papers that have appeared in journals of other languages such as the Russian journals, and this is certainly a most useful aspect.

A. J.

**Radiation Effects in Solids.** By G. J. Dienes and G. H. Vineyard. (Interscience Publishers, New York; India: Asia Publishing House, Bombay-1), 1957. Pp. viii + 226. Price \$ 6.50.

The recent failure due to radiation damage of one of the atomic power stations in Britain has focussed the attention of physicists on the all-important problem of radiation effects on solids. The fact that energetic neutrons and fission fragments would have the ability to displace atoms from their equilibrium positions, which might lead to serious changes in the physical properties of a solid was realised as early as 1942 by E. P. Wigner but most of the work done since then (both technological and basic) has been under classified material till the Geneva Conference in 1955. Studies on this subject are proceeding more intensely than ever and this subject is expected to make great strides in the next few years. In view of the accumulating literature it has become imperative that an attempt be made to survey the present state of knowledge setting forth the basic aspects of the theoretical and experimental advances. Such an attempt has been made with success by the authors, of the book under review. The authors have mostly confined themselves to present the physics of the effects of energetic radiation on solids.

The present interpretation of the changes in the properties of solids brought about by high energy radiation centres round the production of interstitial and impurity atoms. The

process of their formation and statistical enumeration and the dynamics of their movement at different temperature forms the major part of the book. After defining clearly the above-mentioned three entities as also the replacement collision, thermal and displacement spikes (Chapter I), the thesis of displacement production and the basic experiments designed to test the major aspects of the theory are given (Chapters II and III). Point defects and cluster defects and the changes associated with the physical properties such as electrical conductivity, thermal conductivity, elasticity, optical and magnetic properties have been treated. A brief reference is made to the use of X-ray diffraction techniques to observe some types of lattice imperfections. Chapter V deals with the question of the mobility of crystalline defects and the annealing of radiation defects by recombination processes or their disappearance due to diffusion. Chapter VI deals rather too briefly on such varied topics as mechanical properties of metals, changes in the dimensions of uranium on irradiation, radiation growth, phase transformation, precipitation from solid solution, chemical effects, etc.

The authors have concentrated mainly on fundamentals of the processes and do not attempt to give too many details of engineering interest, although most of the striking effects of radiation, affecting technology have been surveyed. The subject-matter has been presented in an attractive and understandable manner and the book can be most warmly recommended, for any one interested in gaining a good grounding of these fascinating subjects.

S. R.

**Three Steps to Victory.** By Sir Robert Watson-Watt. (Odhams Press, Ltd., Long Acre, London), 1958. Pp. 480. Price 30 sh. net.

The title of this book might perhaps induce the readers to believe that they have stumbled upon a trail leading to success in life, and that in just three steps. And if they do turn the pages of this book with any such delectable visions, they will not be utterly disillusioned. For, 'Three Steps to Victory' relates what the enthusiastic, tireless and sustained efforts of the intellect of man could accomplish. It combines in itself an autobiography and a biography—the autobiography of Sir Robert Watson-Watt who, for his pioneering work in the field of radar, has been honoured with the paternity of this conception of human ingenuity and skill, and the biography of the radar, its origin and

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development through the various stages to its present state of perfection.

Though the radar is equally useful in other fields like meteorology and navigation, its importance has been impressively demonstrated in its application to warfare, especially aerial warfare and defence against aerial attack. The introduction of aircraft with all its destructive propensity into the warfare set the warring nations of the world on a race to devise technological ways and means of locating aircraft while air-borne. Radio direction and range-finding or 'radar' for short—from the I.F.F. (Identification, Friend or Foe) to the Oboe which permits the most accurate bombing run, from Gee to the most portable of all radar systems, 'Rebecca-Eureka'—is the operational-technical system brought forth by technologists to fulfil this imperative need. This radar system applicable to naval operations, anti-aircraft gunnery and all other radar-aided military operations—dropping of troops, agents and supplies from air, etc.—was used in the air defence of Great Britain, and in the initial stages of the anti-U-boat war and was responsible for Britain's victory in the Battle of Britain, the Night Battle of the British Cities and the First Battle of Atlantic.

Sir Robert Watson-Watt recounts in this book the birth of the idea of the radar, the early difficulties and failures he encountered on the technical side as well as in the training of personnel required to man the system and the race against time to put Britain under a 'radar cover' before Hitler struck in Europe. What make the reading all the more interesting are the back-stage anecdotes told with a touch of humour and the part played by the Governmental machinery in the birth of a technological system destined to play a very vital role in the history of our times. M. S. S.

**Magnetism.** (The Indian Association for the Cultivation of Science, Jadavpur, Calcutta), 1957. Pp. 232. Price Rs. 7.

This book is a collection of twenty-three papers presented at the Symposium on Magnetism held in 1954 under the joint auspices of the National Institute of Sciences of India and the Indian Association for the Cultivation of Science. They can be roughly grouped under four headings, namely, (1) Discussions on diamagnetic and para-magnetic properties, (2) Magneto-chemical applications, (3) Nuclear magnetic resonance, particularly nuclear induction, and (4) Ferro-magnetic materials. The Inaugural

Address by the late Professor M. N. Saha is immediately followed by two papers on the measurement of magnetic fields.

In spite of its delayed appearance, the book would interest magneto-chemists and workers in the field of modern magnetism and particularly those who are concerned with the nuclear magnetic resonance.

**Advances in Enzymology.** Vol. XIX. Edited by F. F. Nord. (Interscience Publishers, Inc., New York; India: Asia Publishing House, Bombay-1.) Pp. v + 457. Price \$9.85.

The present volume, the nineteenth in the series of the *Advances in Enzymology*, contains five essays written by well-known biochemists and enzymologists. Editor Nord has, of late, been concentrating on less and less number of topics in each volume giving thereby greater attention to a detailed and exhaustive survey in selected fields of enzyme research. Thus in the volume under review, W. Vishniac, B. L. Horecker and S. Ochoa have written jointly the first essay on 'Enzymic Aspects of Photosynthesis'. Therein, they have discussed general patterns of carbohydrate metabolism, carbon dioxide fixation reactions as well as reactions which are light dependent and have very ably reviewed the recent advances in this field. In the second article on 'Mechanism of Oxygen Metabolism', H. S. Mason has dealt with the enzymes, which catalyze the reactions of molecular oxygen under the following three broad divisions: (i) the oxygen transferases, (ii) the mixed function oxidases, and (iii) the electron transfer oxidases. The author observes that with the exception of lipoxidase, the oxygen transferases contain heavy metal which appears to be active in reduced form, while the mixed function oxidases transfer only one atom of the oxygen molecule to substrates. The electron transfer oxidases, on the other hand, catalyze two electron transfer to oxygen only or to oxygen and other acceptors. A distinguishing feature of this article by Mason is the compilation in one tabulated statement of all that is known about metabolic hydroxylation of over a hundred different drugs and other organic substances.

Similarly, the third article on 'Aktivierung von Aminosäuren' written in German by T. Wieland and G. Pfeleiderer and the fifth article in French on 'Les Voies Principales de L'assimilation et dissimulation De L'Azote chez Les animaux' by A. E. Braunstein of Moscow are both comprehensive and lucid in their scope and treatment of the subject. The fourth one



on the "Properties of Papain" by J. R. Kimmell and E. L. Smith is perhaps an article on a rather restricted field of study. Nevertheless, the conclusions drawn have a great bearing on the nature of the mechanism of enzyme action. Thus, the earlier vague and indefinite views with regard to the formation of enzyme substrate complexes have been replaced by chemical formulations, which emphasize compound formation. Further, this study of the properties of papain has shown the important role of thiol groups as well as the significance of 'side chain specificity' in enzyme catalysis. We have yet to know why and how two thiol enzymes such as urease and papain act differently.

The get-up of the book is excellent and there is a cumulative index of Volumes I to XIX towards the end of the book in addition to the usual author and subject index found in every volume of this series. This volume of the *Advances* should, in the reviewer's opinion, prove as invaluable as the earlier ones to all those interested in enzymes and related subjects in biochemistry.

P. S. SARMA.

**Advances in Protein Chemistry.** Vol. XI. Editors: M. L. Anson, K. Bailey and J. T. Edsall. (Academic Press, Inc., New York), 1956. Pp. x + 665. Price \$12.00.

The eleventh volume of *Advances in Protein Chemistry* is similar to its predecessors in that recent developments are reviewed and discussed by people active in and familiar with specific areas of the field of protein chemistry. The first review in this issue is by C. B. Anfinsen and R. R. Redfield and covers Protein Structure in relation to Function and Synthesis. The authors succeed in their stated purpose of reviewing the major recent developments in the study of amino acid sequence in proteins, including a consideration of some basic methodology. Information about the correlation of covalent and non-covalent structure with the physical and functional properties of proteins is also dealt with in this article. Closely allied to this subject is the review article on Column Chromatography of Peptides and Proteins by S. Moore and W. H. Stein. This review is a wealth of information on the methods of separating peptides and proteins by different materials, especially on ion-exchange resins. Specific proteins are discussed in detail under the section on the chromatography of proteins. Choh Hao Li has summarised the work done on the growth hormone (somatotropin) and adrenocorticotrophic hormone (ACTH and corticotro-

pins) in his review on Hormones of the Anterior Pituitary Gland, Part I. The author, in his concluding remarks, poses some legitimate questions about the actual nature of protein or peptide hormones, as they occur in the body in the role of physiologically active catalysts. *Counter-current Distribution in Protein Chemistry* (translated from German) as covered by P. von Tavel and R. Singer deals with a technique familiar in organic chemistry but unfortunately so little used in biochemistry. This review includes a discussion of the basic principles, technical aspects and applications of counter-current distribution. The authors have presented useful information on the conditions under which counter-current distribution can be successfully applied in protein chemistry. F. R. N. Gurd and P. E. Wilcox have an exhaustive review on Complex Formation between Metallic Cations and Proteins, Peptides and Amino Acids. Metal-protein complexes have recently emerged as a central problem of biochemistry, especially of enzymology. This review concerns itself mainly with those metal-protein complexes which are reversible and which can be characterised in terms of chemical equilibria. Pertinent high points in the chemistry of simple metal complexes are also reviewed. Measurement and Interpretation of Diffusion Coefficients of Proteins, as the title indicates, will be of great interest to the physical chemist but should interest biochemists also, as some of the applications of this phenomenon to biological systems are given. Since the mechanism of certain drugs is explained solely on the basis of their diffusion, the review may be perused with profit by the pharmacologist also.

This volume, as the others in the series, is an excellent source of concisely stated information and of references to the literature on the particular subjects covered.

T. RAMAKRISHNAN.

**The Chemistry and Biology of Yeasts.** Edited by A. H. Cook. (Academic Press, Inc., New York), 1958. Pp. 246. Price 25 guilders.

There has been an acceleration of the tempo of investigations on yeast during the past few years. The rapid progress in the different directions, as a consequence, has made it increasingly difficult for investigators in one discipline to keep track of the significant discoveries in the others. This volume, written by a panel of specialists, attempts to integrate the recent advances.

A varied fare is offered to the reader. The chapters on classification, ecology, life-history, cytology and genetics are followed by those on chemical composition, fermentation and respiration, cellular carbohydrates and nitrogen metabolism. Problems relating to yeast technology, pathogenic yeasts, food spoilage by yeasts and flocculation of yeasts are considered in the concluding chapters.

Researches in some directions have been in progress for the past one hundred years and modern concepts are only an integration of the past and present data. "It should be kept in mind, however, that even the latest concepts may have to be reinterpreted and extended as additional evidence arises" (Nord and Weiss, p. 323). In general, the reviews are objective as the following excerpts would show. "For example, the question arose whether such a series of reactions obtained from cell-free extracts or artificial enzyme systems constituted a mirror-image of the exact steps occurring within the living cell. Furthermore, did it represent the only metabolic pathway which the micro-organism could efficiently utilize for catabolic purposes, or were there other metabolic routes by which dissimulation of the same substrate could occur?" (Nord and Weiss, p. 324.)

Objective presentation was apparently not easy, for, Treveleyn remarks "that many authors have burdened their papers with discussions of almost theological subtlety in an effort to fit fact to theory" (p. 420). This is too true with regard to the review on Yeast Cytology (Winge and Roberts, pp. 103-19) in this volume itself. The problems are not viewed from a historical perspective. The discovery of the nucleus in living yeast cells dates back to 1844. That it is a vesicle with a nuclear membrane was shown from living as well as stained preparations as far back as 1896. Guillermond (1902-20) reported as identical structure for the nucleus in stained preparations. In fact, he discussed binucleate stages using the nuclear membrane as a marker.

But none of the above details are found in the review. On the other hand, it is stated: "It is clear that this wide divergency of opinion makes it at present very difficult, if not impossible, to form a clear generally acceptable picture of the structure of the nucleus of a yeast cell and the identity and function of the other intracellular structures" (p. 110). "The basis for this lack of agreement is first to be found in the fact that the yeast nucleus is extremely small (the diameter of the stained chromatin in a resulting nucleus

is only about 0.5-1.5  $\mu$ ) and also because it is a most difficult task to elucidate the actual structure of the nucleus" (p. 109). One is left wondering whether the chromatin occupies the whole of the resting nucleus or only a portion of it. There is no reference to the nuclear membrane described by the earlier investigators.

The review concludes: "Even though many investigators claim to have demonstrated the existence of polyploidy in yeasts, it should be remembered that so-called polyploid segregation may be explicable on the basis of supernumerary mitoses, and binucleate spores" (p. 119). The review on Yeast Cytology recalls to one's mind the following comment of Prof. MacBride, on the impact of Genetics on Cytology, made several years ago. "It was the function of the cytologist to provide the material phenomena upon which the geneticist could build his theories. As genetical research continued to find peculiar and exceptional phenomena necessitating modifications and additions to previous theories, so cytologists attempted to find their equivalents in cell structure and behaviour. Thus arose a peculiar position in which genetic theory outran cytological observations even to the limit of the resolving power of the microscope".

The volume, however, is a mine of information and is worth careful perusal by biologists and biochemists alike.

M. K. SUBRAMANIAM.

**The Grassland and Fodder Resources of India.** (*Scientific Monograph No. 22.*) By R. O. Whyte. (Indian Council of Agricultural Research, Queen Victoria Road, New Delhi), 1958. Pp. iii + 437. Price Rs. 16.

This monograph deals with the review of past and present knowledge and experience on the nature and utilization of the grazing and fodder resources as a whole and to relate this information to other branches of land utilization, agriculture, animal husbandry and forestry in India.

Chapter I is introductory; Chapters II, III and IV deal with livestock problems including Indian resources of feed stuffs, their demand and supply and their quality. The prevailing malnutrition of cattle is explained and the need for proper feeding, which is estimated to step up milk production by 100% is stressed. Emphasis is laid on grassland management to increase fodder production. Statistics are given to show that the feed stuffs and fodder available at

present are highly inadequate and serious quantitative deficiencies are noticed and that their quality is also very poor.

Chapters V and VI deal with the ecology of our grasslands, which are a result of biotic climax. The grassland types in India, in the different agricultural zones, their predominant grass species and their progressive and regressive succession is given. This information will offer a basis for the evaluation of the status of grasslands and facilitates their further improvement.

Chapter VII deals with the present position and possible extension of fodder production in India. Methods are suggested for increasing the production and/or use of improved varieties of crops, which provide the major source of roughage for cattle; exploiting forest trees as a source of fodder under a planned programme; growing of fodder trees along with others in plantations; prohibiting the use of edible oil-cakes as manures.

In Chapter IX, the possibilities of improvement of the village grazing lands are reviewed. The major distribution of cattle is in villages and they depend largely on village grazing lands for fodder. The grazing lands are poor in carrying capacity and almost devoid of any vegetation due to over-grazing. Western methods of raising pastures are not practicable, owing to competition by food and cash crops, so the only practical way is to improve the grasslands on an ecological basis. For this, the ecological status of our grassland is to be determined first, by studying the stage of succession, and then the biotic factors acting on the grasslands should be controlled. The chief factor being the grazing, controlled and rotational grazing and reduction in the intensity of grazing are suggested. The practice common in many areas of having wide bunds, placed frequently in fields, which provide grazing for cattle and controls erosion also, is however not mentioned.

Chapters XI and XII deal with forest grazing, its importance and compatibility between forestry and grazing. The advantages of controlled grazing, the disadvantages of indiscriminate and over-grazing are described. Considering the good and bad of forest grazing, certain recommendations have been made which are useful for proper management of forest grasslands such as adopting rotational and controlled grazing.

In Chapter XIII, the soils of the country, their deficiencies and need for fertilising grasslands and legumes are discussed. A good deal

of useful factual data is furnished. The cropping systems for important crops are described and the need for introducing a dual purpose legume fodder/green manure, in the rotation system is stressed both for increased production of fodder and maintenance of soil fertility.

Mixed farming and its significance so far as our country is concerned is also discussed and ley farming is suggested to be tested in India.

Breeding work on legumes and grasses to evolve a high-yielding vigorous grass which can withstand grazing conditions and to evolve a legume of short duration which can conveniently fit into the cropping system under progress in several Research Stations, is referred to in Chapter XIV.

The agrarian structure of the country is described and the low average holding is stated to be one of the reasons for poor maintenance of livestock.

In the last chapter a description of the important exotic and indigenous grasses and legumes, their utility, suitability and distribution is furnished.

The noteworthy feature of the monograph is the abundant factual data presented to substantiate the statements. The monograph will be a very useful reference book for the agrostologist, forester, animal husbandry man and the agronomist. The book will be a useful base of reference in any future planning of the development of fodder resources of India.

K. S. KRISHNA SASTRY.

#### Books Received

*Utilization of Primary Energy in India.* (Occasional Papers, No. 3.) (National Council of Applied Economic Research, New Delhi.) (Asia Publishing House, Bombay-1), 1958. Pp. 70. Price Rs. 5.75.

*How Television Works.* By W. A. Holm. [Philips Technical Library, Eindhoven, Netherlands; India: Philips (India), Ltd., 221, D. N. Road, Bombay-1], 1958. Pp. xv + 318. Price Rs. 18-94.

*An Atlas of Air-Borne Pollen Grains.* By H. A. Hyde and K. F. Adams. (Macmillan & Co., St. Martin's Street, London, W.C. 2), 1958. Pp. xvi + 111. Price 36 sh.

*The Strategy of the Chemotherapy.* (The Eighth Symposium of the Society for General Microbiology.) Edited by S. T. Cowan and E. Rowatt. (Cambridge University Press, London, N.W. 1), 1958. Pp. viii + 360. Price 35 sh.

## SCIENCE NOTES AND NEWS

### Direct Observation of Weiss Domains

By cooling a nearly eutectic melt, large plate-like single crystals of the hexagonal compound  $\text{BaFe}_{12}\text{O}_{19}$ , the main constituent of ferroxdure, can be obtained. In this process, now in use for some years in the Philips Research Laboratories, extremely thin crystal plates may be obtained under certain conditions. Their thickness is less than a micron and their surface area of the order of one square millimetre. X-ray diffraction photographs of these tiny platelets have shown that they too are single crystals of  $\text{BaFe}_{12}\text{O}_{19}$ , with the hexagonal axis perpendicular to the flat surface.

The special interest of these platelets is that they are reasonably transparent to red light. The transparency of the platelets opens up an elegant method for the direct observation of the Weiss domains in  $\text{BaFe}_{12}\text{O}_{19}$ . The platelet is observed in a polarising microscope with nearly-crossed nicols.

In each Weiss domain in a ferromagnetic material, the magnetic moments of the atoms or ions are aligned parallel, so that in each domain the saturation magnetization exists. The direction of magnetization, which depends on the crystal-shape or stress-anisotropy, differs from one Weiss domain to another. In  $\text{BaFe}_{12}\text{O}_{19}$ , the direction of the magnetization is entirely determined by the very large crystal anisotropy; the preferred direction of magnetization is here the hexagonal axis (c-axis). In the crystal platelets, therefore, the magnetization of all Weiss domains is perpendicular to the flat surface, in spite of the high demagnetization factor of the plate form. The Weiss domains are thus magnetized, with the domain walls all perpendicular to the flat surface. Because the magnetization is so strongly bound to the hexagonal axis in  $\text{BaFe}_{12}\text{O}_{19}$ , no "closing" domains occur at the surface (i.e., Weiss domains with magnetization parallel to the surface), in contrast with the usual situation in other materials.

If a beam of plane-polarized light is now projected parallel to the hexagonal axis on to such a platelet, a Faraday rotation occurs, of magnitude and sign dependent on the magnetization. Suppose that for one domain, the plane of polarization undergoes a rotation described by a right-handed screw; the light passing through an adjacent domain, owing to the oppo-

sitely-directed magnetization, will then undergo an equal rotation of its plane of polarization in the opposite direction, i.e., corresponding to a left-handed screw. An analysing nicol is placed in the emerging beam. By placing this not exactly perpendicular to the plane of polarization of the incident beam, the intensity of the rays passing through adjacent, oppositely-magnetized domains will differ slightly; in this way the whole domain pattern becomes visible.

### A Transistor Thyatron

An important new device recently made available by the General Electric Company of America is the silicon 'Unijunction' transistor, which is a semi-conductor equivalent of the controlled grid thyatron. It is a three-terminal device, hermetically sealed, with a stable *n*-type negative resistance characteristic over a wide range of temperature. The *n*-type silicon bar is mounted between two ohmic base contacts with a *p*-type emitter near the second base contact. The high peak-current rating makes the device useful in medium power switching and oscillator applications, where it can serve the purpose of two conventional silicon transistors. Some of the applications for which the 'Unijunction' transistor is particularly recommended are saw-tooth generators, pulse generators, pulse-rate modulators, pulse amplifiers, multivibrators, flip-flops and time-delay circuits.

### Cleaning of Glass by Ionic Bombardment

It has been found repeatedly that a glass surface facing a pure aluminium cathode gradually develops a hard and optically absorbing deposit on its exposed surface as the bombardment progresses. The rate of formation of the discoloured layer is greatest when the glass is within the cathode dark space. Glasses immersed in a glow discharge with the cathode electrode shielded from the glass surface, may be cleaned without developing a light-absorbing coating.

Further experiments have established that clean glass surfaces may be produced if the electrons leaving the cathode are made to travel in directions which avoid collision with the work surface while the positive ions are scattered by gas molecules and strike the work. Using this system, clean glass surfaces have



been produced in both argon and air, suggesting that a mechanical rather than a chemical process is responsible for cleaning.

It is concluded that electrons formed in a glow discharge decompose hydrocarbon molecules absorbed on surfaces which they strike, whereas positive-ion bombardment removes surface contaminants from glass and at high current-densities may remove components from the glass. Furthermore, clean surface may be prepared in the presence of hydrocarbons providing the electron bombardment is reduced in preference to ion bombardment.

#### Krypton-85 and Diagnosis of Heart Disease

Research at the Public Health Service's National Institutes of Health has shown that krypton-85, a radioactive form of a harmless inert gas, can be used to detect abnormal openings in the wall of muscle dividing the right and left chambers of the heart. Left to right "shunts" of blood which result from defects in the partition of the heart are the commonest form of congenital heart disease. Accurate knowledge of the presence and location of these defects is essential for corrective surgery.

The new diagnostic technique was developed by Research Surgeon Richard Sanders, a staff member of the Clinic of Surgery of the National Heart Institute. The discovery was announced in the January issue of the *Proceedings of the Society for Experimental Biology and Medicine*.

#### Safety in Radiology

Radiation will reduce the life-span of experimental animals, though there is no evidence that doses comparable to those used in diagnostic radiology have any such influence. Radiation can cause leukaemia in animals, and evidence from several sources—a study of the causes of death of American radiologists, and follow-up of Japanese survivors of atomic bombing and of patients given radiotherapy for ankylosing spondylitis—leaves little doubt that irradiation is a cause of leukaemia in man.

Apart from accidents resulting in gross over-exposure, the most important potential danger of diagnostic X-rays is the production of mutations. X-rays are known to cause mutations in experimental animals and in plants, and there is little doubt that they can cause them in man. Future generations may therefore be affected by mutations induced by irradiation of patient's gonads.

Precautions should be combined with the use of filters, the fastest films and intensifying

screens, and the highest kilovoltage that will yield films of adequate quality for that particular examination. If possible the gonads should be directly protected by lead, in the male whenever they might be in the direct beam of radiation or when they are close to the edge of the primary beam. Protection of the ovaries when they are in the direct beam is rarely possible. It is of the utmost importance to keep the edge of the beam as far away from the testes or ovaries as possible; the dose falls off considerably with every inch of increased distance between them and the edge of the beam.—(*British Medical Journal*, No. 5082, May 31, 1958.)

#### Wear

The new international journal, *Wear*, has now been appearing for almost a full year. It is published bi-monthly under the trilingual editorship of Dr. G. Salomon, of Delft (subscription price: 107 sh. 6 d.; \$15; 57 Dutch florins per volume comprising six issues) (approximately 500 pages). (Amsterdam: Elsevier Publishing Co., 1957.) *Wear* is nominally devoted to "fundamentals of friction, lubrication, wear and their control in industry". It is naturally difficult to prevent such a publication becoming narrow and over-specialized and (for a periodical dealing with themes so close to practical affairs) overburdened with technological details. The Journal has successfully avoided this tendency, and the articles are of wide interest and of sober scientific value. Two features of particular value are the participation of Russian scientists, and a systematic abstract of current literature at the end of each issue together with details of current international conferences.

#### Bonding of Bone Fracture with Plastics

Ethoxyline resins have been used successfully in bonding fractured bones in live sheep. These adhesives have proved non-toxic, and microscopically new bone has grown freely through and around the plastic. The affected animals have been able to run about within 2 days, and the fractured limbs have clinically united within 10 days without any plaster casts or supports.

#### Nomenclature of Cell Strains

At the International Tissue Culture Meeting, held in Glasgow, Scotland, last summer, the subject of the nomenclature of cell-strains used in tissue culture was considered and a Study Committee was appointed that made various recommendations. It was suggested that the



following information be given when first mention of a cell strain is given in a publication: (i) whether the tissue of origin was normal or neoplastic and, if neoplastic, whether benign or malignant; (ii) whether the tissue was adult or embryonic; (iii) animal species of origin; (iv) organ of origin; (v) the cell type (if known); (vi) the designation of the strain; (vii) whether the strain has been cloned and, if so, the clone number; and (viii) the reference to the original article in which the strain was described. It was further suggested that the designation of the strain should consist of a series of not more than four letters indicating the laboratory of origin, followed by a series of numbers indicating the strain.

#### Carmine

This compound, which was first described as a reagent for the detection of boron by Zorkin in 1936, has recently been recommended for the absorptiometric determination of small amounts of boron. It has been found that it is in many ways more satisfactory for this purpose than some of the better known reagents.

Carmine is a calcium-aluminium compound of carminic acid, obtained from cochineal. Carminic acid is the effective reactant with borate but carmine is used in preference to the free acid because it is cheaper and does not deliquesce.

The reagent is a bright red powder soluble in water, alcohol sulphuric acid and sodium hydroxide solution. An aqueous solution of carminic acid is yellow at pH 4-8 and magenta at pH 6-2, but with carmine the colour change is not so well marked.

The reaction of boric acid with carmine, as with other anthra-quinone-based dyes, takes place only in concentrated sulphuric acid solution. A solution of carmine in sulphuric acid changes from orange-red to violet on the addition of boric acid.

#### Symposium on Cottonseeds and Its By-Products

The Regional Research Laboratory, Hyderabad, is organising a Symposium on "Cottonseed and Its By-products" from December 5-7, 1958. The following topics will be discussed: Processing and storage of seed and oil, Agriculture, Agricultural studies in cottonseed, Refining of cottonseed oil, Hydrogenation, Solvent extraction, Fundamental studies, By-products, Standards, Statistics and Marketing data, etc.

Information and details can be had from the Director, Regional Laboratories, Hyderabad-9.

#### Symposium on Fungus Diseases in India

It is proposed to hold a Symposium on "Fungus Diseases in India" under the auspices of the School of Tropical Medicine, Calcutta, in the third week of December 1958. The symposium will be divided into the following sections:

Internal Medicine; Paediatrics; Gynaecology and Obstetrics; Dermatology; Surgery; and Medical Mycology.

Papers are invited for the presentation at the Symposium. An abstract of the paper (in duplicate) not exceeding 300 words, should be sent to the Director, School of Tropical Medicine, Calcutta, not later than September 15, 1958, and the full paper (in duplicate) should be sent by November 15, 1958. For any further information and details regarding the Symposium, kindly write to the Director.

#### Geological Society of India

A new All-India Scientific Society under the name "Geological Society of India" has been formed with its Headquarters at Bangalore. The Society will devote itself principally to promote the cause of advanced study and research in all branches of Geology, with special reference to India. Among its avowed aims and objects, the publication of a Journal embodying results of outstanding research work done in the country, in the field of geology, will be an important one.

Further particulars regarding the membership of the Society, etc., can be had from the office at "Mines House", Malleswaram, Bangalore-3.

#### Geological, Mining and Metallurgical Society of India

A Branch of the above Society was inaugurated at Dehra Dun on 8th May 1958, by Hon. Shri K. D. Malaviya, Minister of Mines and Oil of the Government of India.

Shri A. M. N. Ghosh, Technical Member of the Oil and Natural Gas Commission, is the President and Shri P. V. Dehadrai, Senior Petrologist of the Oil and Natural Gas Commission, is the local Secretary.

#### Award of Research Degree

Utkal University has awarded the Ph.D. Degree in Chemistry to the following candidates for their theses indicated against each: Shri Gokulananda Mahapatra, "Chemical and Biological Investigations of Some Thiazole Derivatives"; Shri Shiba N. Mahapatra, "Synthetic Investigations on Terpenes".

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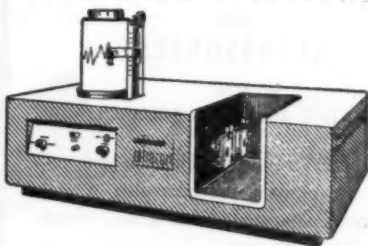
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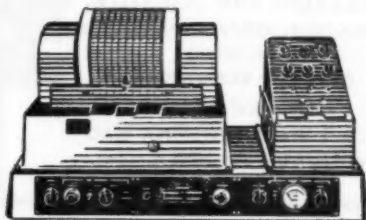
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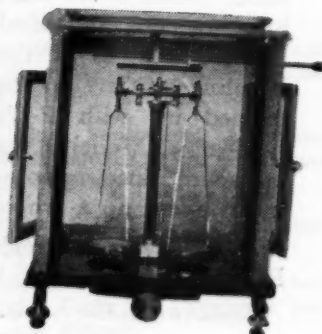
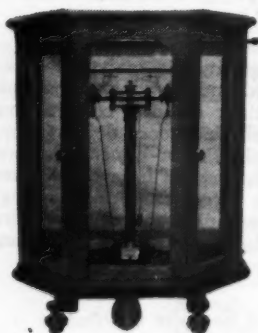
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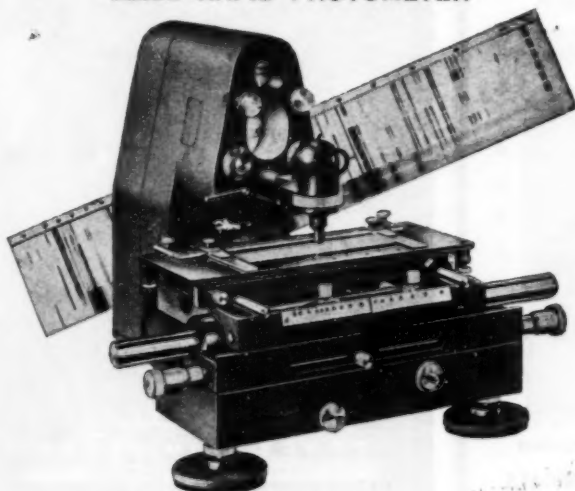
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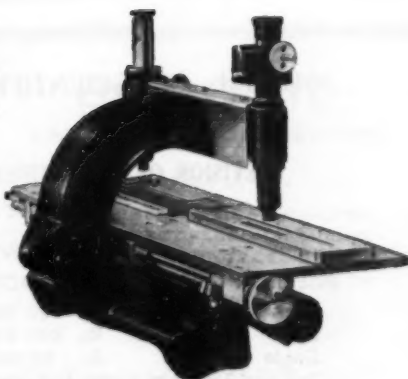
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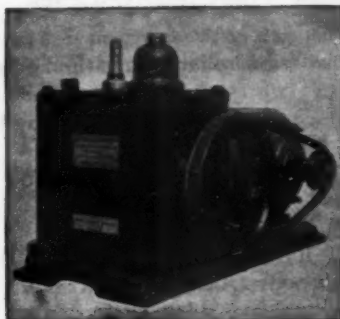
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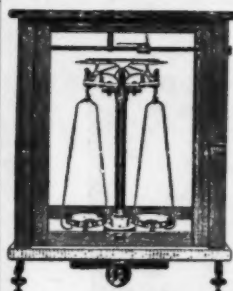
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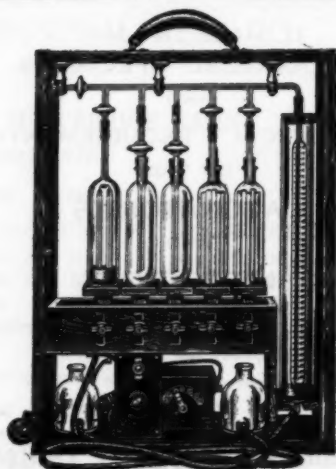
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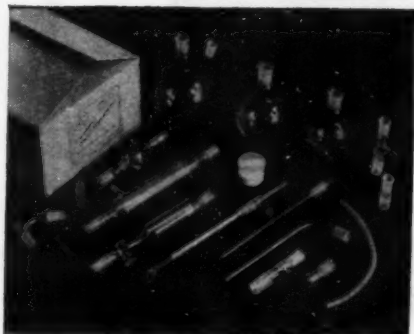
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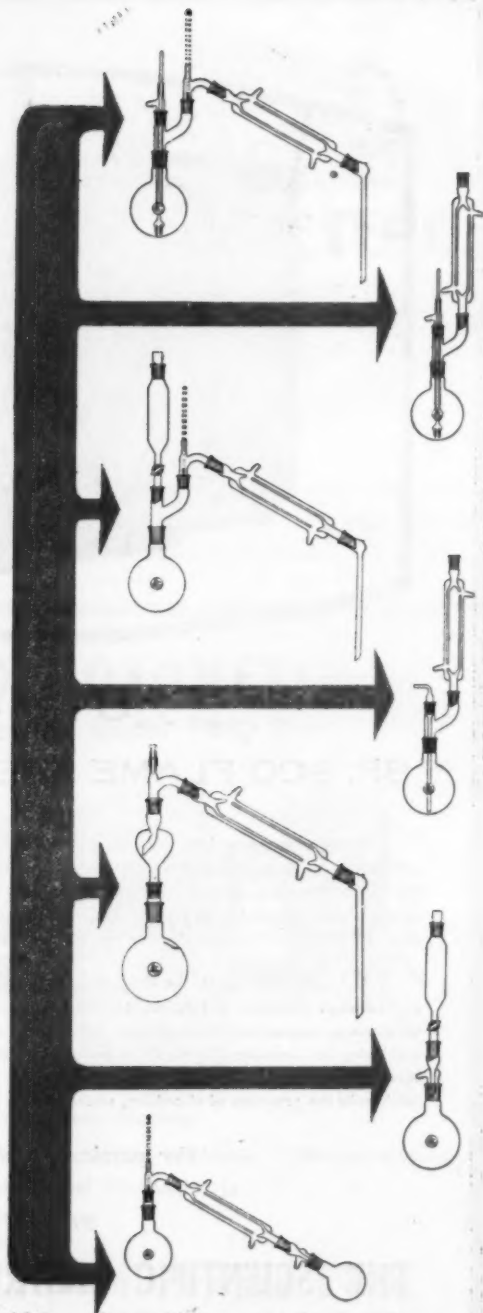
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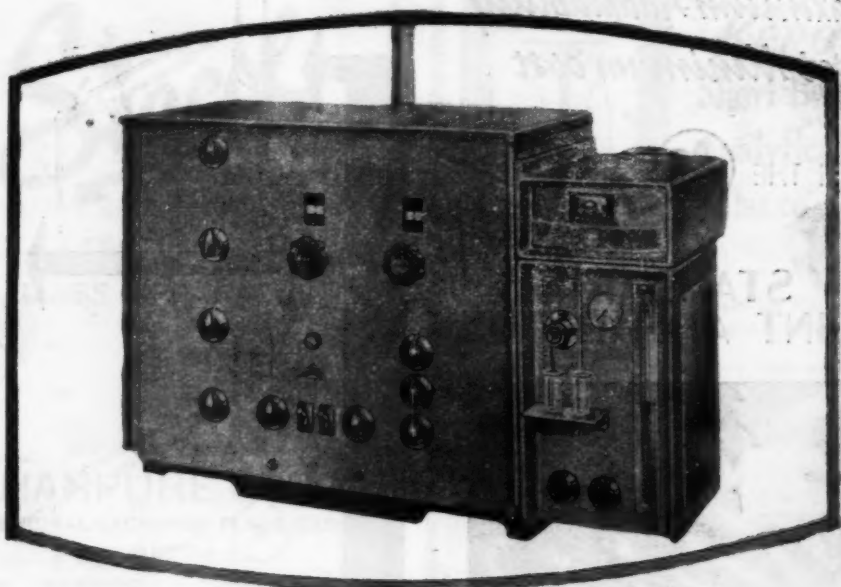
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